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PARALLACTIC FLUOROSCOPY AS AN AID IN THE BRONCHOSCOPIC EXTRACTION OF FOREIGN BODIES[1]

by

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In the 19th century considerably more than half the patients who had aspirated foreign bodies into their trachea and bronchi used to die, as a rule after protracted and severe suffering. In 1895 KIRSTEIN was the first to pass a rigid tube into the larynx and trachea, and shortly after that KILLIAN passed a tube into a bronchus. Since then their many successors have developed the bronchoscope into the indispensable aid it now is, and the former high mortality has been very greatly reduced mainly by bronchoscopy, thoracic surgery, and roentgen examination. In 1934, according to JACKSON, it was only between 0.5 and 1 %.

In dealing with radio-opaque foreign bodies which cannot be seen by bronchoscopy — whether their position be too far out in a peripherial bronchus or whether hidden behind masses of granulations —, the obvious method would seem to attempt extraction with the aid of fluoroscopy. As far as I have been able to ascertain, this was done by D'HALLUIN as early as 1909.

Screening was at first used in one plane only. The patient, was placed on the examination table in supine position with the roentgen tube underneath; the direction of the beam was thus vertical and dorsoventral. As it was considered impossible to judge the vertical distances in this way, it was held that the single fluoroscopic examination was limited to the detection of the presence or absence of a foreign body. ROLLIN reported that in examining children he had tried to eliminate this deficiency by turning their bodies slightly. When visiting the Charité

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in Berlin in 1938 I watched VON EICKEN and CHAUOL perform a fluoroscopic bronchoscopy in trying to extract a dentist's drill from a very peripheral bronchus. The patient was placed in a swivel chair to enable CHAUOL to pilot the forceps into the correct bronchus by turning the chair.

In 1916 the American GRIER introduced fluoroscopy in two planes at right angles. He reported several cases of foreign bodies in which fluoroscopy in one plane had been used. One of these cases was a child of two years, who had aspirated an ordinary pin, which had gone down into a small bronchus near the diaphragm. Under fluoroscopy in the antero-posterior direction alone, the bronchoscope was passed down to within three quarters of an inch of the pin. At this point several bronchioles came off in different directions, and as he was unable to say whether the pin was in front of or behind the end of the instrument, and as the bronchoscope could not be passed any further down, the pin was not found. By the new method of fluoroscopy in two planes at right angles he thought that he could give the bronchoscopist valuable information as to the proper means of removal. The removal from the bronchus of a foreign body which cannot be seen is always a dangerous procedure, especially if a sharp point has been caught in the bronchial wall.

Several books have since been published, all of which emphazise the great superiority of the bi-plane method. The largest and most authoritative of these is JACKSON and JACKSON's in »Annals of Roentgenology», in which the authors state that bi-plane fluoroscopy is necessary for success. Unfortunately however, everything gives the impression that extractions with the aid of bi-plane fluoroscopy take a long time; MANGES wrote in 1933 that an assistant kept check on the time, telling him when fifteen, thirty, forty and fifty minutes were up. He related further that in exceptional cases he had even worked for a whole hour. ROLLIN stated that in one case the extraction of a nail, which broke in two when grasped, took no less than $3^1/_2$ hours, including the tracheotomy. It will be readily understood by everybody how great a draw-back this is to both patient and doctor.

Apart from the time factor, fluoroscopy in two directions will be found quite impractical where delicate shadows such as fine dental needles or semi-opaque tooth-fragments are concerned. It can hardly be expected that such objects could be reasonably well seen on the screen in the transverse diameter of a somewhat bulky patient, especially if the image of the foreign body should fall within the shadow of either heart or diaphragm.

We have, therefore, here at the Carol. Hosp. simplified the procedure and are now able to guide extraction forceps to its objective within a few minutes.

Extraction is performed with the patient in supine position on an examination table with the roentgen tube beneath. The bronchoscope is introduced into the relevant main bronchus, and is then under fluoroscopic control directed towards the foreign body. Due regard is paid to the localization of the foreign body in the sagittal plane, which is determined immediately before by a roentgen examination. The extracting forceps are in this way piloted down to the foreign body. On the fluorescent screen it is possible to observe directly whether the forceps are moving straight towards the foreign body or deflected medially or laterally of it. Next, the roentgen tube is moved to and fro transversely in the horizontal plane, and from the relative displacement on the screen of the images of the foreign body and the forceps it is possible to establish whether the forceps are entering the correct bronchus or not.

The movement of the tube produces an almost stereoscopical impression. If the image of the foreign body should move *more* than the image of the forceps, it is situated dorsal to this. Should it move less, it is ventral to the forceps. When the forceps have entered the correct bronchus, both images move equally, and not until then must the endoscopist try to grasp the foreign body. After only one or two attempts this method is generally successful.

Incidentally, I may say that my examination table is equipped for bi-plane fluoroscopy, but on no occasion have I had to resort to that method.

Since the opening of the Caroline Hospital 6 years ago, we have had some 40 cases of foreign bodies in the trachea or bronchi. In 6 of these, which are described in detail below, fluoroscopy was used in the attempts at extraction. I do not know, however, the exact procedure in Case No. 1, as another roentgenologist was operating on that occasion. In the other cases I have done the fluoroscopic localization myself.

Case 1. ♂, *21 years. J. No. 633/1940.*

Caught a cold in 1938, which left a persistent cough with yellowish, offensive mucous expectoration. In May 1940 the patient was called up for military service. A roentgen examination of his lungs on 15 May, 1940, disclosed an infiltration in the right base with numerous cavities and fluid levels as well as an elongated, slightly irregular, amorphously streaky calcified shadow (Fig. 1), which looked rather like a calcified ear of corn. The patient stated that he had been doing some threshing, but was not aware of ever having inhaled any ear.

The patient was sent to the Caroline Hospital for examination by a specialist. Bronchoscopy revealed that in one of the most distal lateral and posterior bronchial branches of the lower lobe, a greatly reddened and swollen mucous membrane, almost completely occluded the lumen. A vain attempt was made to fish for a foreign body in this bronchus with the extraction forceps. Visibility in the bronchoscope was obscured by a copious flow of secretion.

Three days later another extraction attempt was made, using fluoroscopy. Using the fluoroscope in two directions at right angles, fine forceps were inserted into the lower

Fig. 1.

Fig. 2.

Fig. 1. A partly calcified ear of corn in the lower lobe of the right lung.
Fig. 2. A dental root-canal reamer in a dorsomedial branch bronchus in the left lower lobe.

lobe bronchus leading towards the abscess cavity. Both the forceps and the foreign body could be well localized on the fluorescent screen, which proved a good help in guiding the former to the latter. The foreign body was grasped by the forceps, but broke, and had to be removed in small pieces. A roentgen examination after the extractions disclosed no calcifications in the cavities or the adjoining bronchi.

Case 2. ♀, *24 years, J. No. 2184/1943.*

During dental treatment on the 4 September, 1943, the dentist dropped a dental root-canal reamer into the patient's mouth; this was aspirated and produced an attack of coughing. A roentgen examination in the local hospital showed the reamer lying at the entrance of the left main bronchus, its head being situated distally and its point directed upwards. No foreign body could, however, be discovered in the trachea or the main bronchus by subsequent bronchoscopy but a control examination by roentgen showed that the reamer had moved much further distally. For lack of instrumental resources necessasy for its extraction, the patient was transferred the same day to the Caroline Hospital.

On her arrival here, another roentgen localization was undertaken (Fig. 2), followed by examination with our most slender bronchoscope. The mucous membrane was slightly more irritated in the left than in the right main bronchus, and abundant muco-pus was found in the bronchus of the left lower lobe. The bronchoscope was taken past the first dorsal bronchus and a couple of ventral bronchi as distally as possible. As no foreign body could be seen as far down as the bronchoscope could go, a radiopaque ureteral catheter was inserted in a dorso-medial bronchus of the lower lobe which, judging by the roentgen pictures (Figs. 3 a and b), should have been the direction in which the foreign body should be found. Control roentgen showed that in the antero-posterior

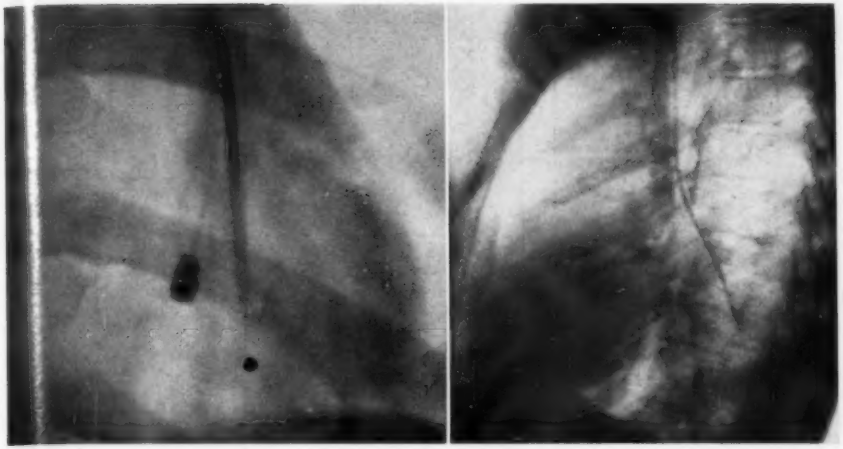

Fig. 3 a. Fig. 3 b.

Fig. 3. The same patient after introducing a contrast catheter by visual bronchoscopy. a) Front view. b) Lateral view.

direction the catheter was in exactly the same plane as the foreign body, while in the lateral projection it was about 1 cm. from it. The reamer had thus evidently entered a bronchus medial to the dorsal lower lobe bronchus.

Another attempt to extract it with the aid of *fluoroscopy* was made. Arrangements had been made for fluoroscopic control in two directions at right angles. With the horizontal beam it was almost impossible to see the point of the reamer. By moving the roentgen tube underneath the table, however, the forceps could be *rapidly* guided into the correct bronchus so as to reach the foreign body. After several vain attempts during which the forceps slipped off repeatedly, the reamer, which was probably wedged into a bronchial branch, was brought up successfully. The whole operation took about 30 minutes.

Case 3. ♀, *28 years, J. No. 1991/1944.*

Towards the end of July, 1944, all the patients' teeth were extracted under general anaesthesia in a local hospital. This was followed by fever for a week, with increasing cough. A month later the fever recurred, and when her temperature mounted to 40° (104° F) the patient again sought admission to the hospital. A roentgen examination of the lungs revealed the root of a tooth some way down the left upper lobe bronchus.

Since the opening of the upper lobe bronchus could not be seen on repeated bronchoscopies, due to swelling of the mucous membrane and still less any foreign body, the patient was sent to the Caroline Hospital in Stockholm.

After localisation of the tooth root by another roentgen examination (Fig. 4), an ordinary bronchoscopy was first performed. A fairly copious amount of purulent secretion now welled forth from the left main bronchus. Abundant granulations were observed in the orifice of the left upper lobe bronchus. These were cleaned out, and attempts were made to get hold of the foreign body with forceps and other instruments, but without success.

Fig. 4.

Fig 5 a.

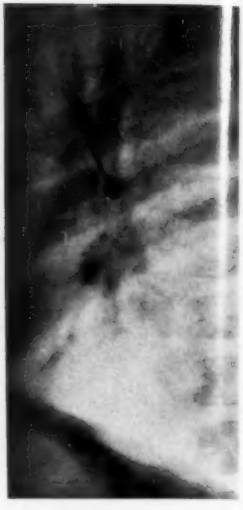

Fig. 5 b.

Fig. 4. A root of a tooth in a dorsal branch of the left upper lobe bronchus.
Fig. 5. A pin in the left lower lobe bronchus. a) Front view. b) Lateral view.

Another attempt at extraction, this time with the aid of *fluoroscopy*, followed. This proved that the forceps had only reached the vicinity of the tooth root, which was lying in a dorsal bronchus in the upper lobe. As it was impossible to reach it with the ordinary forceps, a bent radio-opaque urethral catheter was tried, and by moving the roentgen tube to and fro we rapidly succeeded in guiding the catheter into the correct bronchus. In doing so we could see on the screen that the tooth could be moved by the catheter. Attempts were made to get hold of it by means of a long loop, but without result.

The attempts at extraction were then discontinued hoping that the patient would be able to cough up the now loosened foreign body. This actually happened the next day.

Case 4. ♀, *2 years, J. No. 2474/1944.*

On 22 October, 1944, a pin got into the patient's pharynx and was aspirated when she laughed. Roentgen examination in the local hospital showed a glass-headed pin stuck in the left main bronchus, the pin having entered head first. In the absence of suitable instruments, the patient was sent to the Caroline Hospital.

After another roentgen examination on admittance here to localize the pin (Fig. 5 a and b), bronchoscopy revealed that the point of the pin was sticking into the anterior wall of the left main bronchus, and that its head extended down into the bronchus of the lower lobe. The pin was grasped with the forceps, and we tried to push its glass head down so as to bring the point of the pin back into the lumen of the bronchus. Repeated attempts were made, but the point could not be set free.

An attempt at *extraction under fluoroscopy* was therefore made. At first the pin could only be gripped about 1 cm. above its glass head, the remainder of the pin being outside the bronchial lumen. It was then possible to push its head so far distally that

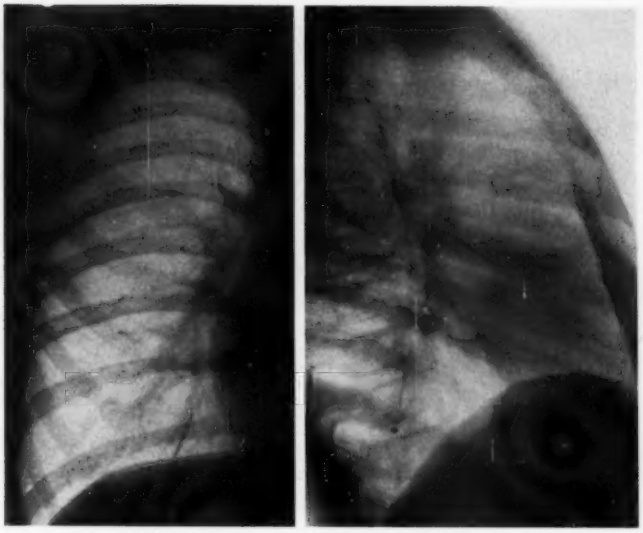

Fig. 6 a. Fig. 6 b.

Fig. 6. A pin in a dorsal bronchial branch of the right lower lobe. a) Front view. b) Lateral view.

in the next attempt the pin could be gripped by the middle, and further attempts were made to push it still more distally. On the screen it looked as if this had been successful, but as soon as we let go off the pin, it slipped up again. Its glass head must accordingly have stuck in some small bronchus which did not allow it to move any further back. The elastic return of the pin as soon as it was let go favoured the view that the whole lung tissue was being moved distally with the pin.

A radiogram taken after the attempts at extraction showed that the point of the pin was lodged in the anterior mediastinum in front of the trachea. The distinct pulsating movements of the pin made us suspicious of its point being in contact with the aortic wall.

As the position of the pin and the narrow limit of possible movements made an extraction by bronchoscopy technically impossible, it was decided to try to remove the pin by an operation from without.

The following day, however, the patient died from purulent bronchitis.

In the post mortem (No. 253/1944) the glass-headed pin was found in the left main bronchus slightly distal to the bifurcation, its point penetrating the bronchial wall and the mediastinal connective tissue right up to the wall of the aortic arch. The aortic wall was not completely perforated, but small tears in the intima, corresponding to the point of the pin, could be observed.

Case 5. ♀, *6 years, J. No. 2281/1946.*

On 12 September the patient was threading whortleberries on a pin. When eating some, the pin happened to enter her mouth, and she thought that she had swallowed it.

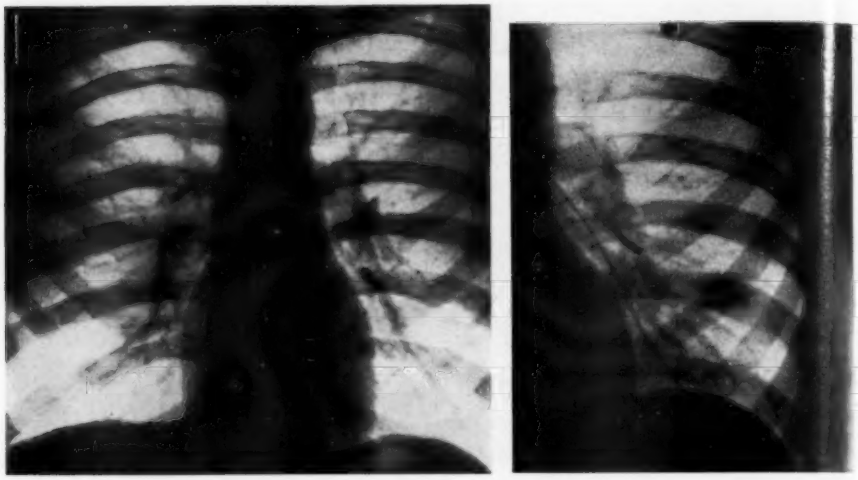

Fig. 7 a. Fig. 7 b.

Fig. 7. A metal splinter in a pulmonary artery. a) Front view. b) Radiogram of the lung in an oblique position with a contrast catheter in a dorsal bronchial branch of the left lower lobe.

The blocks of fig. 7 a and b I have borrowed from the C. V. Mosby Company, St. Louis.

She was sent to the local hospital, where a roentgen examination showed that the pin had entered the right lung. Two attempts, both unsuccessful, were made to extract it under an anesthetic. The patient was therefore sent to the Caroline Hospital.

On her arrival here she was again examined by roentgen (Figs. 6 a and b), when it was found that the pin was lying fairly far peripherally. From the first it was therefore decided that *extraction under fluoroscopy* should be attempted.

The bronchoscopy revealed a fairly large amount of secretion emerging from the right main bronchus. The bronchoscope was inserted into this bronchus and with the aid of the roentgenologist was directed towards the dorsal bronchus of the lower lobe. The forceps were introduced into this bronchus and entered a bronchial branch medial to the pin the first time, one lateral to the foreign body the second time, but afterwards was piloted into the correct bronchus, where it was possible to feel the foreign body with the forceps. Aided by fluoroscopy, the pin was now gripped, and could on the screen be seen to come up without difficulty. The whole operation did not take more than a few minutes.

Case 6. ♂, *21 years, J. No. 000/0000.*

In November 1944 this patient was admitted in the Caroline Hospital for a left-sided basal bronchopneumonia. The roentgen examination (Figs. 7 a and 7 b) disclosed — besides the pneumonic consolidation — a very dense foreign body of irregular configuration, about 1.5 cm. long, about 1 mm. thick, and 7—8 mm. broad, in a bronchus of the inferoposterior part of the left lower lobe, about 7 cm. distal to the bifurcation.

As he patient said that he had very likely on one occasion inhaled a foreign body, visual bro chroscopy was performed on the indication of a foreign body in the left bronchial tre . The mucous membrane in the main bronchus was found to be swollen and red, but no foreign body could be seen. A catheter and an extraction forceps, were introduced wit the aid of fluoroscopy to within about 1 cm. of the foreign body. As it was not pos ible to penetrate further, the operation was discontinued, and it was assumed that the obstruction was due to a swelling of the bronchial mucous membrane.

A week later a fresh attempt at extraction under fluoroscopy was made. Extraction for ps and a radio-opaque catheter were inserted in the direction of the foreign body. The catheter could then be observed on the screen to be thrusting against a minor carina in the bronchial branch about 1.5 cm. cranially of the foreign body. As any attempt to bring it nearer to the foreign body met with elastic resistance; if, on the other hand, the catheter was allowed to go on, it would move medial, lateral, ventral, or dorsal to the foreign body. This left the definite impression that the foreign body could not be situated in the bronchial tree, but must lie in the lung tissue.

On the direct question whether any metallic splinter had ever entered his body, the patient replied that while doing lumberwork, an iron splinter entered his left groin 18 months ago.

After the two fluoroscopic bronchoscopies, the epicritical argument accordingly led to the assumption that the iron splinter in the lung might have entered through the groin.

A renewed examination of the roentgen pictures established that the metallic foreign body was a fairly thin flake, and was thus of the same appearance as a piece of the battered base of the steel wedges used in lumbering. The size and position of the metal splinter moreover made it unlikely that it could have descended into a bronchus as fine as those found 7 cm. from the bifurcation.

Our diagnosis was therefore that this was a foreign body in one of the pulmonary arteries, and the patient was accordingly operated upon, with the result that the foreign body was found stuck in an arterial branch in the place indicated by the radiograph.

In these cases, *fluoroscopic bronchoscopy* has thus proved of the very greatest importance in the extraction of the foreign bodies or in determining their positions. By utilizing the roentgen parallax, the extraction forceps could be guided very rapidly and reliably, and this is obviously of the greatest importance.

At the same time it should not be concealed that the literature agrees upon and generally stresses the great risks connected with the use of fluoroscopic bronchoscopy. As soon as the limit of vision is reached, the bronchoscopist should only proceed with the greatest caution and handle extraction forceps with a very light touch. Should he meet with any resistance, no force must be used, as this might easily injure some vessel. Several cases of vascular injuries have been described, and I myself have witnessed an accident of this kind abroad. In this hospital no such accidents ever occurred.

SUMMARY

The author describes the localization and bronchoscopic extraction of foreign bodies by use of the fluoroscopic parallax. This method has been used in six cases, which are described in detail. He has found this method to be rapid and accurate. For speed it is superior to the biplane method.

ZUSAMMENFASSUNG

Verf. beschreibt die Lokalisierung und das bronchoskopische Entfernen von Fremdkörpern mittels der Parallaxe. Diese Methode kam bei sechs Fällen zur Verwendung, die eingehend beschrieben werden. Er hat diese Methode zeitersparend und exakt gefunden. Inbezug auf die aufgehende Zeit ist sie der Zweiflächenmethode überlegen.

RÉSUMÉ

L'auteur décrit la localisation et l'extraction bronchoscopique des corps étrangers à l'aide de la parallaxe. Cette méthode a été employée dans six cas qui sont décrits en détail. Il l'a trouvée rapide et exacte. Au point de vue du temps qu'elle demande elle est supérieure à celle des deux plans.

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FROM THE ROENTGEN CLINIC OF THE VIBORG TOWN AND COUNTY HOSPITAL, DENMARK
(CHIEF: KRISTIAN OVERGAARD, M. D.)

A CASE OF OSSEOUS CHANGES IN A PATIENT WITH HEMOPHILIA[1]

by

Jens Petersen

The cardinal symptom of hemophilia — the tendency to bleeding and the greatly protracted bleeding time — has been known since the earliest times of history, but not until the middle of the last century was the disease established as a definite pathologic entity. Since then, its clinical picture has been studied and elucidated in detail, so that it is now well defined. Also its hereditary behavior, with the female as conductor and the male as carrier of the disease, has been made perfectly clear.

The increased tendency to bleeding shows itself in protracted hemorrhages, often menacing to life, which may result even from very slight and seemingly insignificant lesions. They may occur in any part of the organism, but since it requires a trauma to produce them there are nevertheless certain places in which they are particularly apt to set in. As the most important of these, next to the skin and to surfaces in general, may be mentioned the joints, and of these particularly the knee joint. It is therefore natural that changes in the joints already very early became recognised as an element in the symptomatology of hemophilia (GRANDIDIER, 1855). The first to classify these pathologic changes in the joints systematically was KOENIG (1892), who divided them into three successive phases: (1) simple hemarthrosis in one or several joints, without any other demonstrable changes; (2) panarthritis, with more or less pronounced reaction or destruction of the joint capsule or the ends of the bones; (3) the regressive stage, in which the acute bleedings become rarer and less profuse, at the same time as there is a tendency to healing and secondary arthritis deformans.

Numerous later studies, by ENGELS (1917—18), FREUND (1925), REINECKE & WOHLWILL (1929), SOLIS-COHEN & LEVINE (1934), PRIP

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BUUS (1935) have on the whole confirmed this division, and at the same time roentgenologic and supplementary pathoanatomical studies — the latter first undertaken by FREUND — have thrown further light on details of the changes marking the different phases, so that we now have the well-known, well-defined, almost classic roentgenologic picture of the changes in the joints of hemophiliacs.

It has been found, however, that also hemorrhages outside the joints may sometimes produce roentgenologic changes. Thus, STARKER (1919), REINECKE & WOHLWILL (1929) and several others have reported cases in which hemorrhages on the femur have given rise to changes both clinically and roentgenologically so closely resembling a sarcoma that the correct diagnosis was only reached as result of the microscopic examination. A similar case, of changes in a right thumb, resembling a tumor, has been reported by FIROR & WOODHALL. Further, BECKER (1942) and MUELLER (1943) have shown that changes simulating a sarcoma may develop on the basis of hemorrhages in the soft tissues. They both designate them by the term »resorption tumors in hemophiliacs». BRAILSFORD later uses the term »pseudosarcoma in hemophiliacs» as a common designation for all these changes.

While hemophilic changes in the soft tissues are thus rather well known, one finds on searching through the literature only the description of a single case with osseous changes, recorded in a paper by FORFOTA in 1931. As his study bears an important relation to the present communication, I recount his case in some detail.

The patient was a man, 30 years old, descending from a typical family of bleeders. Already as a child numerous hemorrhages into kidneys and joints. At fifteen, both knee joints much deformed, almost ankylosed. At fourteen, large hematoma in right hip- and pelvic region following a trauma; had to keep in bed four months, after which time there remained a constant resistance in the right side of the pelvis. Shortly before admission again a large hemorrhage in the same place, and at admission there was there found a smooth, elastic, fluctuating filling, the size of a child's head, which lost itself diffusely on the anterior side of the femur and the lateral side of the hip. The filling occupied the entire right side of the pelvis, and could be felt upwards in the abdomen to the level of the umbilicus. The roentgen examinations showed severe changes in both ankle- and knee joints, right hip joint and both elbow joints, all characteristic of hemophilia. Most interesting in this connexion are, however, the severe roentgenologic changes found in the right iliac bone, the squama of which was twice as broad as normally, while the iliac crest was less curved and its outline somewhat irregular, the normal osseous structure partly effaced owing to numerous large, cyst-like rarefactions sharply defined peripherally and separated from each other by thin, sharply traced bone trabeculae. In several places there were broader bone trabeculae, though, of normal structure, but seemingly thickened. When an operation eventually had to be done, it was found to be a case of a large hematoma. Owing to a secondary infection it became necessary, for the sake of the drainage, to remove a small piece of bone. This showed no sign of tumor. There was no microscopy. The patient died owing to the infection. There is no record of postmortem findings.

A similar case has been observed in our service. The patient is a small farmer, single, aged 33 years. Apart from the hemophilia he has always been well. There is no known case of bleeders in the family. He remembers that he already before he was of school-age often would get »blue spots» (extravasations), even as the result of slight traumas. As a boy he was often subject to pains and swelling of the knee- and ankle joints. In 1921, he was admitted to the surgical service here for the trouble in the knee, and was treated with puncture and plaster bandages. In 1945, he was admitted to the medical service here for examination with a view to getting disablement pension owing to increased pain and restricted mobility in the hip joints, especially the left, and in the left knee joint, developed in recent years. Of the examinations made during this hospitalisation must be mentioned in the following.

Clinically, the most interesting was the finding, in the left flank and over the left greater trochanter, of a large, deep-seated, fluctuating accumulation, delimited upwards by the iliac crest. A little above the latter and continuing upwards to the scapula there was a similar intumescence. The mobility in the left hip joint was slightly restricted; there was some tumefaction and rather marked limitation of motion in the left knee joint. In the other joints there were only slight changes.

Other examinations: Urine, normal. Wassermann, negative. Blood precipitation, 12 mm./h. Hemoglobin, 79 per cent (Sicca). Erythrocytes, 4,410,000. Leukocytes, 6,360. Dry preparation, nothing particular. Index, 0.5. Leukocytes, 70 per cent; lymphocytes, 23 per cent; monocytes, 5 per cent; eosinophils, 2 per cent. Blood platelets, 318,780. Osmotic resistance of red blood cells: incipient hemolysis, 0.44; total hemolysis, 0.36. Bleeding time, 4 min. (but afterwards there came protracted, seeping bleeding, necessitating application of a clamp and, later, péan). Clotting time, 14 min.

Roentgen examination of both knee joints showed on the left side some halisteresis of the bones. The intercondylic fossa was broad and flat, the joint surfaces, especially that of the patella, very irregular. There was no certain narrowing of the interarticular space. The joint surfaces were slightly sclerosed, and there were slight signs of osteophytic reaction at the margins and on the intercondylic eminence. On the right side there were similar changes, but less pronounced.

Roentgen examination of the pelvis and the hip joints showed in the squama of the left iliac bone a large, cyst-like rarefaction, 9 by 11 cm. in diameter, rather sharply defined medially, where the margin was slightly sclerosed; laterally the demarcation was less sharp and somewhat irregular, and here there was, especially downwards, a distinct expansion of the bone, whose contours were irregularly curved. In the rarefied portion was seen a faint trabecular design. The hip joints showed nothing positively abnormal. In the space between the neck of the left femur and the squama of the left iliac bone, and extending a little over these, there was a faint, irregular opacity, presumably an indication of incipient calcareous deposit. Extending laterally downwards from the left ischial tuberosity toward the lesser trochanter and branching Y-shaped around the latter there was a sharply defined calcareous shadow, barely 1 cm. broad. On the anterior side of the right hip joint, a similar shadow extended from the upper part of the joint vertically downwards toward the lesser trochanter.

After his discharge there were steadily increasing pains in the knee- and hip joints, and he was therefore admitted again, this time to the surgical service, for renewed examination with a view to disablement pension (Journal no 3774/46). Clinically, there was now found ankylosis of the left hip joint and marked limitation of the mobility of the left knee joint. The mobility in the other joints of the lower extremities was only slightly restricted. Corresponding to the left femoral triangle there was an osseous swelling, almost as large as a closed fist, solidly united with the femur.

Fig. 1.

Fig. 2.

Fig. 3.

Roentgen examination of both knee joints showed that the changes had now become much more pronounced. On the left side there was increased halisteresis of the bones. There was marked, irregular narrowing of the interarticular space; the joint surfaces were very ragged, and there seemed to be incipient ankylosis. The intercondylic fossa had become still wider. There were now seen a few roundish, slightly irregular rarefactions in the osseous structure of the ends of the bones. Also the changes on the right side had become more pronounced.

Renewed roentgen examination of the pelvis showed the cyst-like rarefaction to be almost unchanged; still, it was a little more well-defined downwards, and the margin there a little more sclerosed. The lateral definition was still somewhat irregular, and one had the impression of increased expansion there. There was now also a rarefied area, about 2 cm. in diameter, immediately below the upper margin of the iliac crest. The calcification between the left femur and the squama of the iliac bone was much more pronounced, the other calcifications unchanged. Roentgen examination of both elbow joints showed only very small, atypical changes.

As the result of the roentgen examination shows, the changes in the knee joints are typical for »bleeder joints»; there can therefore be no doubt but that they are due to the repeated hemorrhages into the joints, determined by the hemophilia.

With the changes in the iliac bone it is different. Similar changes have only been described once before; it is therefore reasonable to ask if we do not here, in fact, have to do with an independent affection, which has simply in this case happened to occur in a hemophiliac. To get a histologic diagnosis would, of course, be extremely difficult; we must therefore in the first place try to eliminate other affections, and then examine whether it is possible that such changes can have occurred on the basis of the hemophilia.

As differential diagnosis FORFOTA suggests, among others, tumor; but he says that also such diseases as multilocular echinococcus, chondromatosis, myelomas, local osteitis deformans with cyst development, etc., must be considered. In view of the anamnesis, the clinical picture and his patient's condition as a whole he thinks, however, that these may reasonably be excluded. As already said, an operation which eventually became necessary showed that it was a case of a large hematoma, and that the osseous tissue did not macroscopically show any signs of tumor. Chiefly on the basis of the anamnesis, FORFOTA expresses the belief that the changes were due to pressure erosion of the bone, caused by this large hematoma, and that the expansion was due to reactive new formation of bone. At the same time, he points out, though, that this theory hardly explains the cystic character of the bone; but he mentions the possibility that the presence of the septa found may have been due to some portions of the latter, corresponding to the course of the nutrient vessels, having offered greater resistance than the others to the pressure of the hematoma. Finally, he also mentions the possibility that it may have been a matter of subperiostal, or perhaps intra-osseous,

hemorrhages. One has the impression, though, that he rather believes the increased pressure to be the causal factor, also in this respect.

Our case gives rise to about the same questions respecting the differential diagnosis as those mentioned by FORFOTA, but in view of the anamnesis, the clinical findings and the patient's condition as a whole we are most inclined to believe that the changes found are due to his hemophilia. In contrast to FORFOTA, we think it improbable that they should be the expression for a simple erosion caused by pressure of the hematoma. Against such an explanation speaks in the first place — what he also points out in relation to his case — the cystic character of the bone, secondly the expansion of the latter. The roentgen examination did not in any place show sure signs of periosteal neoformation; the smooth, rounded contour of the bone rather speaks against any such. Moreover, a review of the literature shows that the conception of simple pressure erosion as the sole causal factor has already been the subject for consideration and doubt. REINICKE & WOHLWILL's paper from 1929, which among other things comprises studies of bone changes in connexion with subperiosteal hematomas, shows that these authors were surprised at the changes found, which they did not believe could be due to simple pressure erosion alone. For lack of better explanation they advance the hypothesis that chemical peculiarities in the blood of hemophiliacs may perhaps be in some way responsible.

We therefore believe that the changes are due to subperiosteal or intra-osseous hemorrhages with subsequent cystic development. This also accords with the most general opinion respecting the causes of the development of cysts. Both POMMER (1919) and LOOSER (1924) think that localised cysts in bones develop on the basis of intra-osseous hemorrhages. Later, this theory has been accepted and further elaborated by GESCHICKTER & COPELAND, who also believed that they could demonstrate a genetic relation between cyst development and giant-cell tumors. They show that a destruction of osseous tissue, whether it is due to hemorrhage or to some other cause, gives rise both to an osteolytic and a regenerative process from the surroundings. Whether one of these — and, if so, which of them — in a given case gets the upper hand will depend on the local conditions. In the beginning, the osteolytic processes will predominate, owing to the poor blood supply, and as a result there is seen a peculiar transformation of the osteoclastic cells, with formation of giant-cells. In certain cases this might result in the development of a giant-cell tumor, in others the result will be the development of a cyst, owing to the reparative processes. Associated with a cyst one should therefore always find both giant-cells and regenerative changes; and GESCHICKTER & COPELAND's investigations have also shown this to be the case.

JAFFE & LICHTENSTEIN have since maintained that local cyst development is a disease *sui generis*, due to a local change in the development and growth of the bone. They divide the development of the cyst into two phases, an active and a latent, and believe that they can show that the active phase is only found where the cyst still retains its connexion with the epiphyseal line, but that it enters into a latent phase at the moment when this connexion is lost. They think that both the usual location of the cysts and the age of the patients in whom they are found support this view of the developmental process. Neither have they in their microscopical examinations — or, at any rate, only in a few cases — been able to find any giant-cells.

There is still considerable doubt, however, about the correctness of JAFFE & LICHTENSTEIN's theory, both because a genetic diagnosis based on the location of the cyst according to its degree of development and on the age of the patient seems rather inadequate, and because the absence of giant-cells in the microscopical picture is not convincing, since the number of these cells — and, consequently, the chance of finding them — must in some degree depend on the comparative strength of the osteolytic and the regenerative processes. Moreover, GESCHICKTER & COPELAND have, as already mentioned, demonstrated the presence of such cells, and in this respect it is also worth noticing that already REINICKE & WOHLWILL in their studies of bone changes associated with subperiosteal hematomas found osteoclasts and giant-cells in relation to these. On the basis of GESCHICKTER & COPELAND's theory I therefore believe that the changes found must be considered as due to subperiosteal or intra-osseous hemorrhages resulting from the patient's hemophilia.

As regards the calcifications about the hip joints, a comparison of the films with the anatomy of the region seems to show that in this case it can hardly be a matter of myositis ossificans, but rather of ossified hematomas situated in the intermuscular spaces. This is also in analogy with a few cases of Volkmann's contracture in hemophiliacs, described by HILL & BROOKS. In one of these, microscopy of a removed piece of the muscle showed the changes characteristic for that condition, after which the changes could only be interpreted as due to hemorrhages in the intermuscular spaces. It may also be noted that there is no record in the literature of any case of myositis ossificans in hemophiliacs.

SUMMARY

The author reports a case of cyst-like changes in the left iliac bone and calcifications about both hip joints in a patient with hemophilia.

ZUSAMMENFASSUNG

Verf. berichtet über einen Fall von zystenartigen Veränderungen des linken Os ilium und Kalkablagerungen in der Gegend beider Hüftgelenke bei einem an Hämophilie leidenden Kranken.

RÉSUMÉ

L'auteur relate un cas de lésions d'aspect kystique de l'os iliaque gauche, et de calcifications au niveau des deux articulations coxo-fémorales, chez un malade atteint d'hémophilie.

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FROM THE DEPARTMENT OF ROENTGENOLOGY AT ULLEVÅL HOSPITAL, OSLO
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ROENTGENOLOGICAL EXAMINATIONS OF ILEUS[1]

by

J. Frimann-Dahl

To investigate radiologically chronic affections of the intestines, is the natural and common practice. It is unfortunately not so usual to send acute intestinal conditions for similar investigation. It is meanwhile difficult for many radiologists to achieve sufficient experience to master this important field of medicine and it has also taken time for the surgeon to become confident in this diagnostic method: thus the matter still warrants attention.

Such examinations will naturally be limited to those hospitals to which acute abdominal conditions are admitted, and, if roentgen diagnosis is to make its proper contribution, certain main conditions must be fulfilled. In the first place, the Roentgen Department must be so situated as to afford easy to and from transportation of the patients. In parenthesis it should be noted that this is a factor to be taken into consideration when hospitals are built and the departments established. In the second place, there must be full confidence and intimate co-operation between surgeon and roentgenologist. It must also be presumed that doctors are familiar not only with the diagnosis of ileus, but also are well versed in the radiological diagnosis of all that may be classed as the *acute abdomen*. The difficulties of differential diagnosis are, in fact, many; nor can one differentiate, clinically, all those cases with possible intestinal obstruction. It is important, therefore, that there should exist in book-form, a guide to the radiological diagnosis of all acute abdominal conditions. (FRIMANN-DAHL.)

Before discussing the radiological appearances of ileus it would be as well to examine for a moment the concept of ileus as a whole and in its various sub-groups. To understand the roentgen findings one must be clear as to which forms are the most common and, in addition, to be sure

[1] The introductory Address to a meeting of the Norwegian Surgical Society held on Nov. 1, 1946; submitted for publication Jan. 30, 1947.

of which terms one is to use for the rarer conditions. It is obviously of importance that the radiologist and the surgeon should clearly define the different types of ileus and that they should use the same terminology.

Ileus, of course, is an old term and includes indeed, a jumble of different acute abdominal conditions. Common to each, however, is some form or other of obstruction to the intestinal tract. Naturally every case of stagnation or impeded passage of the bowel contents cannot be regarded as ileus. The obstruction must ordinarily be so pronounced that the bowel gives the definite impression of working against resistance thus producing the symptoms of an acute abdominal condition. The terminology is thus not very precise and yet surprisingly continues to be used thus vaguely.

In Norway, the term »intestinal twist» is used but this bears but little relation to the basič pathology. Obstruction to the passage of the intestinal contents arises most frequently from adhesions and neoplasms with local occlusion and without any kinking or twisting of the bowel. Kinking of the small intestine in any case occurs remarkably seldom, and, though volvulus, both primary and secondary to adhesions, may occur, it is relatively seldom that the term volvulus of the small intestine is applicable. This in itself is remarkable when one considers how long the small intestine is and how it normally lies in tightly packed loops. The term volvulus is applicable rather to the large intestine where twisting and volvulus formation is well known.

In English and American literature, the term ileus is not so much used as it is here. The most common, mechanical, type is called »intestinal obstruction» while the functional type is termed ileus, as, for example, in »inhibition ileus» in paralytic conditions.

We have already indicated the distinction between two forms of ileus, the mechanical and the paralytic. The paralysis is often not marked and then we usually use the term paretic ileus. A spastic form also has been instanced by many authors, but the mechanism here is less clear, and doubtful. Volvulus should be considered in a separate group, for though it is in the widest sense a form of ileus, the mechanism of its production is so individual that it is appropriate to consider it separately.

In order to survey the different types of intestinal obstruction, the following scheme has been adopted; there are admittedly a number of earlier classifications but they mostly seem rather complicated and unpractical.

I. *Mechanical Ileus.*

(1) *Simple obstruction* within the bowel itself: *e. g.* tumour, concretion, or invagination. (*Obturation Ileus.*)

(2) *Obstruction from without* from adhesions, inflammatory infiltration, tumour, enlarged viscera etc. (*Obstructive Ileus.*)

(3) *Incarceration* under adhesions, internal herniae etc. (True *Strangulation Ileus.*)
(4) *Volvulus.*

II. *Functional Ileus.*

(1) *Paralytic and Paretic Ileus*, in peritonitis, peritoneal irritation, and post-operative ileus.
(2) *Ileus* following neuro-vascular changes.

It is by no means always that conditions of ileus are strictly limited to one or other of these groups. In appendicitis or pelvic peritonitis, for example, there may be adhesions adding a mechanical factor. In these cases we talk of a *mixed type ileus* for which, as we shall see later, we find tolerably certain radiological criteria. If we go further in our classification we find that the most important condition, both from the point of view of diagnosis and of incidence, is mechanical ileus of the small intestine and it is this form to which we shall mainly refer when we come later to discuss intestinal obstruction. It is, indeed, obstruction of the small intestine which is the most dangerous and the most difficult to diagnose. Moreover, adhesions and incarceration with resultant ileus occur in most cases in the small intestine and particularly in the ileum. Adhesions to the colon are found relatively often but though they may lead to kinking and twisting, they seldom lead to strangulation.

As early as 1906, the ileus expert WILMS pointed out the necessity for differentiating clinically between the usual simple obstructive ileus and true strangulation. This has later been shown to be of great importance in the understanding of the radiological findings. On this point, however, there is meanwhile no little confusion. Most adhesions which cause an occlusion of the intestine produce a simple obstruction and the radiological findings are, in the main, easy to interpret. A true strangulation, however, in which both ends of an intestinal loop are nipped, can also give a typical Roentgen appearance, but, what is more important, this dangerous form may not infrequently show such scanty signs that it may be overlooked. We are thus in the rather unfortunate position that the most serious conditions can be the most difficult to diagnose. In an earlier communication upon ileus, I have shown that such cases of true strangulation with scanty radiological signs comprised about 5% of all cases, but, if one notes the special symptoms, suspicion can nevertheless be directed to the diagnosis of intestinal obstruction.

The following scheme of the clinical and radiological findings will illustrate the difference between a simple obstruction and a true strangulation (which in experiments is usually known as »closed loop»). The simple statements are naturally not absolute but suggest broadly the main tendencies.

Acute Mechanical Ileus of the Small Intestine

Obstructive or Obturation Ileus (simple occlusion)	*Strangulation Ileus (incarceration of the bowel)*
Clinical Signs	
Shock and collapse not present at the beginning.	Initial shock and collapse.
Pulse initially unchanged.	Pulse most often small and rapid (can also be full)
Pain initially moderate, gradually increasing.	Severe initial pain.
No vomiting in the beginning but later projectile vomiting.	Immediate reflex continuous vomiting.
Local meteorism first, and later diffuse.	Diffuse meteorism.
Faeces and flatus may be passed and bring temporary relief.	Faeces and flatus usually held back; mucus and blood.
Peritoneal exudate difficult to demonstrate.	Occasionally haemorrhagic exudate.
No tumour palpable.	Often a tumour palpable. (May be confused with torsion of an ovarian cyst.)
Peristalsis and borborygmi.	Little peristalsis and few sounds heard.
Radiological Signs.	
Obstruction and Obturation.	*True Strangulation.*
Hoop-shaped, gas-filled loops of bowel above the stenosis.	Few small bubbles of gas.
Definite fluid levels in motion especially in subacute conditions.	Often small fluid levels with little movement. (Can also be long fluid levels.)
No tumour shadow visible; often fluid-containing loops of small bowel.	Tumour-like opacity with multicircular outline.
Little or no gas in the colon; if present, diminishing. Increasing gas indicates incomplete stenosis and improvement.	Scanty gas in colon and sometimes in caecum and ascending colon.
Exudate often difficult to see.	Abundant fluid, but can be difficult to make out.
Free diaphragm.	Diminished movement.
Little deformity of other organs in acute conditions; more in subacute.	The fluid-filled loops can exert pressure on other organs, *e.g.* kidneys, ureters, bladder, stomach and bowels.
Usually come relatively late to roentgen investigation, perhaps repeatedly, and ultimately with barium.	Appear relatively early for investigation because of pain, and barium is seldom used.

The main difference then between these forms of ileus is that in simple occlusion the intestine with the mesentery and blood vessels is not much affected, whereas interference with nutrition, infarcts, necrosis and gangrene are found most frequently in true strangulation where a large or

smaller loop of bowel is compressed. Obviously it will often be difficult or even impossible to differentiate in a single case, between these two forms but nevertheless it is evident that the distinction must be attempted as both pathogenesis, symptomatology and prognosis differ in the two groups.

Pathogenesis: Most cases of obstruction to the small intestines are due to the common herniae. In the material here discussed are included only internal herniae and other occlusions due to adhesions, tumours, stones, etc. By far the largest group then becomes ileus due to adhesion formation. Most adhesions are caused by previous infections or post-operative cicatrisation. A smaller group of ileus is caused by congenital malformations, Meckel's Diverticulum and so on. The small intestine is that most usually affected and we shall see that the obstruction is commonly situated to the right inferiorly. This is because most infections in the abdomen occur in the right iliac fossa and in the pelvis. The same region is also the site of most operations. (Post-operative adhesions.)

A high obstruction, which is comparatively rare, has generally other causes. Herniation into peritoneal pockets (the so-called Treitzske hernia), abdominal herniae and neoplasms are here the causal agents. Time does not permit of consideration of each of these forms of ileus and we must concentrate upon the radiological findings in the commonest forms of ileus of the small intestine. There is a decided preponderance of women in our series. All ages are represented.

Roentgenological Findings: About 1920 came the first publications which showed that acute ileus of the small intestine could be diagnosed radiologically. It was new that contrast-media were not used and only straight films were taken both lying and standing. Since then the technique itself has undergone little change though experience in differential diagnosis has widened, and the interpretation of the films has become much more sure.

The contrast medium which forms the basis of the roentgen findings is produced naturally in the gas which is found in the intestine in ileus, and in the fluid which is either swallowed or secreted in the bowel. Normally gas is found in the colon but not in the small bowel. There may occasionally be found small single gas bubbles in the small intestine, but these pass over into the large intestine within half an hour or so. An exception must be made in the case of small children up to two or three years of age in whom gas may be found in the small intestine. Gas in the small bowel of adults indicates stagnation and delayed passage. In ileus conditions, as we shall see, are the complete reverse of the normal, and gas is found in the small intestine but not in the large. Formerly, one assumed the gas seen by Roentgen to be the product of putrefaction in the gut but

then it was shown that this gas consisted for the most part of nitrogen and it was considered unlikely that the bacterial flora should be able to produce large amounts of such a gas. Could the gas come from the blood by diffusion into the bowel? Many believed this for a long time but later American works showed that if such was the case, it could only be to a very small extent. Different figures are given for the percentage of nitrogen, thus HIBBARD and WANGENSTEEN give 60—70% nitrogen, and in Denmark ANDERSEN and RINGSTED state that 90% of the gas in ileus is nitrogen. The latter authors conclude that in any case, diffusion of gas from the blood to the intestine is not possible. On this important point there is thus a certain divergence of opinion but the main result is clear, namely, that the most part of the intestinal gas (above the stenosis) in ileus is the product of *swallowed atmospheric air*. In the intestine itself a large amount of gas is formed but this is carbon dioxide and is soon reabsorbed. Oxygen also is comparatively quickly reabsorbed and the amount of gas produced by putrefaction is without significance, at least, in ileus of the small intestine. The patient in this way provides his own contrast medium by swallowing air. Fluid, naturally, can also be swallowed but is mainly the product of intestinal secretion.

Technique: For clear contrast we use, of course, horizontal rays because the gas and fluid are then clearly seen with fluid levels. Most patients can stand and are photographed in the upright position; at the same time all are screened to see whether the lungs are clear, the diaphragm freely moving, and whether the fluid levels are moving. If there is the slightest suspicion of the lungs a film is taken of the thorax. The left lateral position is a standard projection partly for patients who cannot stand and also to obtain another view which shows up the gas columns as well as, or perhaps even better than the upright position. In order also, to decide the site of the stenosis, it is necessary to take a picture in the left lateral position as the gas then moves towards the stenosis which is, as mentioned above, usually to the right side.

One can, in fact, often see the site of the stenosis in the upright position but it should be remembered that the gas in the intestine will tend to move up and to the left, away from the stenosis, and will tend to draw with it the individual bowel loops in the same direction. In differential diagnosis it is likewise of importance to take a picture in the left lateral position both in order to see if possible opacities remain lying in the pelvis and also to discover if fluid levels are formed in the ascending colon. One may perhaps, at the same time, notice a complicating pneumo-peritoneum and this aids the assessment of the amount of fluid in the peritoneal cavity. Further, especially when ileus of the large intestine is in question, a film in the right lateral position may be necessary. In this position one can best follow the column of gas in the colon down to the stenosis and ve

Fig. 1.

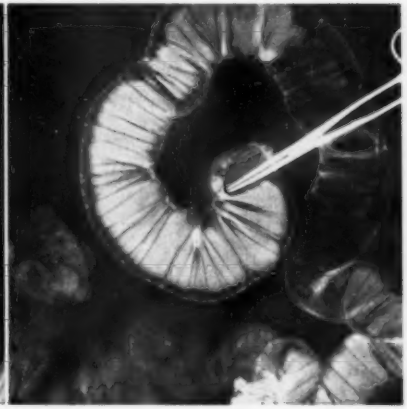

Fig. 2.

Fig. 1. Mechanical ileus of small intestine. Patient practically without clinical symptoms.

Fig. 2. Autopsy finding of small intestine in case of ileus. Circular foldings above the stenosis. (Jejunum.)

know that the obstruction lies usually in the left iliac fossa in ileus of the large intestine.

It may be advisable for the roentgenologist to make a brief clinical examination of the patient. A short history and an estimate of the general condition is important and palpation and auscultation of the abdomen should be the rule.

Symptomatology: (1) *Simple Obstruction:* The typical findings are as follows: above the obstruction gas and fluid collect in varying amounts, at first scanty and gradually increasing. With horizontal rays hoop-shaped loops are seen with two small fluid levels, generally one in each limb of the hoop. While the bowel is active it strives to press its contents past the obstruction and it is for this reason that the column of gas shows upright loops that are arched in form on account of the peristaltic movements. On screening such a patient one can see that the fluid levels rise and fall and this finding that fluid levels are at *different* heights in the same loop is an almost certain indication that we are dealing with ileus of a mechanical type. If, on the other hand, the fluid levels are found at the same height it cannot be assumed without further investigation, that the ileus is a paralytic one (Fig. 1). In the first place the examination may take place at the precise point when the moving fluid levels are just opposite each other, and in the second place the intestines may suspend activity for periods of ten to fifteen minutes. If a number of films are

taken at intervals, the situation may be found to have altered considerably. The intestine may again have begun its efforts to force a passage and the fluid levels show definite differences in height. It is the rule that the nearer the condition approaches strangulation, the less peristalsis is seen. The greatest peristalsis is found in subacute conditions where the bowel has had time to hypertrophy. In simple obstruction one must also reckon with both the form in which the obstruction is complete, and with that in which it is incomplete. In the latter case gaseous distension of the bowel may be little marked making the diagnosis difficult at first.

It is obviously important that the intestine be definitely *distended* with gas and fluid. Gas is found in the small intestine under normal conditions also but the bowel is then not notably distended and the gas passes over into the colon within half an hour or so. Similarly in various infective conditions there may be gas in the small bowel but the loops are then not distended to any extent. In mechanical ileus there is a degree of distension that alters the appearance of the intestine so that even apart from the balooning of the prestenotic loops, the picture strongly indicates the diagnosis. When gas dilates the small intestine, the mucosa can no longer alter its contours; the *autoplastic changes in form* cease and the folds become definitely circular (Fig. 2). This is seen most beautifully in the jejunum where the mucous membrane is normally thicker and more abundant than in the ileum and the folds persist even when the bowel is greatly distended. The folds are shorter in the ileum but here also one can note their circular form even as far as the ileo-caecal valve. Permanent circular folds in the small intestine (Kerkringi folds) are thus a sign of ileus and upon the appearance of the mucosa one can often decide which portion of the intestine one is dealing with. This is again of great importance when planning operative procedures.

As already mentioned, another important radiological finding is *the absence of gas from the colon*. The portion of the intestine below the stenosis will contract and tend to empty its contents. Gas is fairly rapidly absorbed or passed *per vias naturales* and if the obstruction is complete no gas passes from the ileum to the colon in any case. Occasionally in ileus of the small intestine a certain amount of gas is found in the colon but this is either because the obstruction is incomplete or because there previously had been large amounts that had not yet had time to be reabsorbed. That gas in the large intestine may be due to an enema, I mention merely. At the same time, of course, fluid also is introduced and the production of fluid levels in the colon may lead to difficulties in diagnosis. Patients with ileus should not, therefore, be given enemata before roentgenography. If there is nevertheless gas in the colon of a patient with ileus of the small intestine (and who has not had an enema), it is important to notice that fluid levels are not seen. This is because the contents

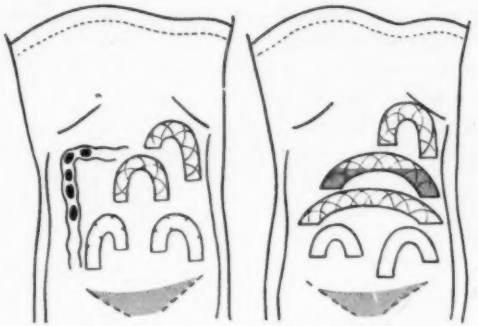

Fig. 3. Acute ileus of the small intestine. Stenosis in ileum. No gas, only scybala in colon. Small exudate in the pelvis.

Fig. 4. Ileus of the small bowel. Long duration.

Fig. 3. Fig. 4.

are not fluid but on the contrary are mostly scybalous masses (Fig. 3). In a patient with paralytic ileus or peritonitis the contents soon become fluid so it is accordingly well worthwhile to note in a case of ileus of the small intestine whether or not the colon contents are solid.

The main rule then, is this: In simple mechanical ileus the loops of small intestine are distended hoop-shaped and show horizontal fluid levels. The colon most usually contains no gas and may not be visible at all. Should there be some gas in the colon then fluid levels are not seen. The presence of solid scybalous masses indicates the absence of an infective process.

There are also other details of the picture of a mechanical ileus that we must touch upon briefly here. In many cases there is quite a rapid exudation of fluid into the peritoneal cavity; this fluid is easy to see if the intestine is gas-filled, but is difficult to demonstrate if the collection of gas is scanty. A large amount of fluid tends to obliterate the detail in the picture of the abdominal cavity and thus forms an even background for the affected loops of bowel.

If the ileus is of comparatively long duration, for example, three to four days, the gas usually increases in amount and more and more loops appear. These lie above each other extending as bands across the abdomen upwards and *to the left* and not infrequently giving an appearance suggesting a step-ladder (Fig. 4). The loops must on the whole take this direction partly because the liver lies to the right and pushes them to the other side, and partly because the root of the mesentery extends from the right iliac fossa to its upper limit at the upper pole of the left kidney. The greatly distended loops of an ileus of long duration or in the postoperative period, can show especially long fluid levels. As a sign of paresis, the fluid levels remain at the same height in the same loop.

In mechanical ileus of the small intestine also, we note that there is

seldom gas in the stomach, the reverse of conditions obtaining in peritonitis or paralytic ileus. Even though one must reckon with gastric aspiration as here playing a part, there is already on first examination strikingly little gas in the stomach. It is not a particularly significant sign but is worth noting. On screening, as a rule, one finds a good diaphragmatic excursion and clear costo-phrenic angles whereas, in peritonitis, the excursion is nearly always restricted. At the same time one commonly sees collections of fluid in the costo-phrenic angles and basal atelectatic strips on the lungs, while in mechanical ileus the lungs are clear.

Strangulation Ileus: There are, of course, many different degrees of incarceration in this type of intestinal obstruction, and a precise classification is therefore difficult. Cases where the compression is slight are often impossible to distinguish from those of simple obstruction. In our series of some 300 cases of ileus of the small bowel examined radiologically during a period of 9 years and for the most part the result of adhesions, there were 40 cases of definite incarceration. On examining the roentgen findings in these latter cases, it appears that about 2/3 of them showed definite signs of ileus whereas in the remainder there were scant findings. If the strangulation is *incomplete*, then the roentgenogram will show gas both above the stenosis and in the involved loop (Fig. 5). This we have often had the opportunity to demonstrate by comparing the radiological findings with those at operation. The whole picture is so like that of simple obstruction that confusion is likely.

One thing to note, however, is that the fluid levels in these cases tend to remain more at equal heights than in simple obstruction. It is difficult to be certain whether this is always so as reports of the operations are often rather imprecise as to the degree of stenosis.

When the incarceration and stenosis is *complete* a number of cases show the typical picture of ileus of the small intestine while in others there are but scanty signs though gas and fluid are found always in the *prestenotic loops*. Why this is so, we cannot yet answer though presumably it depends partly upon whether the patient swallows air or eructates. Or it may depend upon the state of the intestine and whether it is paralysed or not and whether it still has the power to force the gas against the stenosis (Fig. 6).

In an earlier communication I have drawn attention to this important matter and also mentioned that even though the radiological findings are few, they can nevertheless indicate not only the diagnosis of ileus but the more specific diagnosis of incarceration. The compressed loops which are well-filled with fluid form together a tumour-like opacity with a characteristic multi-circular border. This may encroach upon other organs such as the ureter or bladder and be demonstrated by urography. Both radiologically and clinically such an intestinal tumour can be confused with

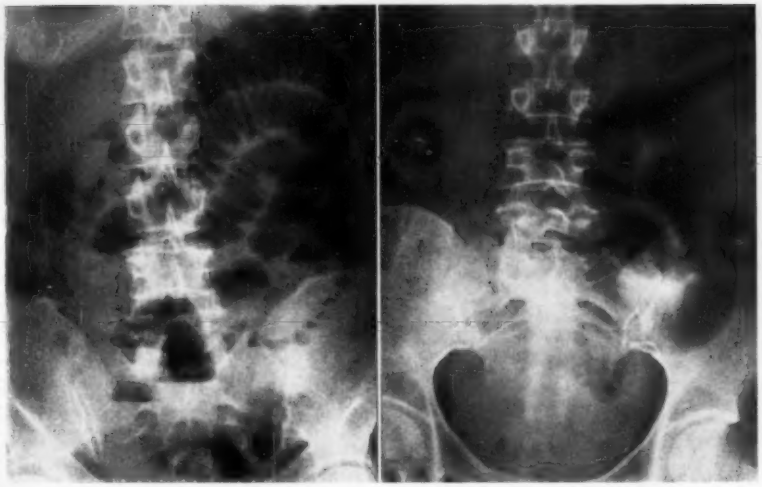

Fig. 5. Fig. 6.

Fig. 5. Incomplete strangulating obstruction. Gas above the stenosis and in the incarcerated coils. Picture similar to that of an simple obstruction.

Fig. 6. Complete strangulating obstruction. Gas in prestenotic coils. Incarcerated loops show tumourlike filling in the pelvis.

an ovarian cyst. One must lay particular stress then, upon the bowed outer contour of the intestine as opposed to that of the ovarian cyst which is as a rule smooth and rounder. In this series marked distension of the compressed loops of small intestine was never found and we therefore believe that the so-called VON WAHL'S sign with ballooning of the incarcerated loop does not occur in ileus of the small intestine. It is important to note whether there are together with a tumour-like opacity, a few small gas bubbles with horizontal fluid levels. This should make one suspect that one is dealing with an incarceration. The colon also is empty of gas in these cases unless the condition has gone on to the development of a peritonitis. When a patient, therefore, is sent with suspected ileus for roentgen examination and the findings are few while the clinical symptoms are pronounced with continued severe pain, both the radiologist and the surgeon must realise that inconclusive radiological findings do not preclude the diagnosis of ileus.

A film in the horizontal position shows, now and then, the intestine in concentric rings or bows indicating a secondary torsion or volvulus of the small intestine. One gets the impression that the intestines are arranged in a coil and this finding suggests the correct diagnosis of an

intestinal twist. Otherwise the picture of volvulus of the small intestine is not very characteristic and the diagnosis merely of ileus of the small intestine is made as a rule.

How early can a Roentgen Diagnosis be made?

Experimental investigations have shown that already after 2—3 hours gas and fluid have collected proximal to the occlusion (HIBBARD, WANGENSTEEN, OCHSNER). Clinically it has been shown that an exact diagnosis may be made radiologically about 3 hours after the onset. (KOCH, FRIMANN-DAHL). Usually however, it takes rather longer for the signs to be sufficiently well developed to produce positive radiological findings. After 6—7 hours the roentgen diagnosis will ordinarily be made with certainty. Apart from the cases of true strangulation mentioned above, we have also found scant radiological signs in a case of simple obstruction where the patient was investigated 8 hours after the onset. The roentgen findings were more or less negative but the patient was nevertheless operated upon on the basis of the clinical findings.

In this connection one should mention that a patient with the symptoms of ileus in whom the roentgen findings are inconclusive should be investigated repeatedly. The findings change rapidly enough for radiological observation to give conclusive indication of how the condition is developing. PETRÉN believes that if a patient after 12—24 hours after the onset of the illness shows no radiological signs of ileus this diagnosis may be excluded. If one excepts certain cases, especially of true strangulation, one can assume the correctness of such a rule.

Examination with Barium

As mentioned before, a patient with an acute abdominal condition is best investigated without barium. In many cases of ileus, however, a contrast medium must be used both orally and as an enema. In ileus of the small intestine barium is given most often by mouth and in that of the large intestine, by enema. Orally it is given in small amounts of 2 dessert-spoonful or at the most half a tumblerful.

The indications are when a patient is suspected clinically of ileus but in whom the roentgen findings are at first few, or when the signs are of partial ileus and the seat of the obstruction is difficult to determine. The question, in fact, arises when the indications for operation are not quite certain and the patient is nevertheless to be observed. With barium it is easy to see the fluid-filled loops of small intestine which generally sink down into the lower abdomen and appear as large wide opaque bands. The intestine is often visible without barium because of its fluid content

Fig. 7.

Fig. 8.

Fig. 7. Roentgenogram of small intestine, after peroral barium, shows site of stenosis.
Fig. 8. Combined ileus. Mechanical hindrance by appendicitis.

but the contrast medium indicates better the site of the stenosis (Fig. 7). Barium has in addition the advantage of deciding more easily a relative obstruction. Indeed these can often be difficult to diagnose just because gas is not held up and thus does not distend the bowel loops. Even though the amount of gas in the colon enables us to judge the degree of the stenosis, the passage of the barium gives a more certain indication. Should a little barium pass the stenosis it is comparatively easy to see it collect in the caecum and ascending colon. Repeated films indicate a delay according to the retention of the barium. An easy and complete survey of the delayed passage and the intestinal dysfunction is in this way achieved.

For a long time formerly it was objected that *barium* should not be given in ileus and one may still see this stated in books that are supposed to be modern. Most of those who are concerned with radiological diagnosis are, however, agreed that barium can and must be used in the above circumstances (LAURELL, SANTE, FELDMAN, KOCH). The reason for the advice against the use of barium in ileus is some idea that the barium will inspissate and increase the degree of obstruction. Apparently the precise opposite occurs. In occlusion, at least of the small intestine, there will always be fluid proximal to the obstruction and as the barium descends it is diluted and gradually becomes thinner and thinner, ultimately becoming quite transparent. Even should the stenosis be in the colon no harm arises as here also a collection of fluid dilutes the barium.

Since barium is now used so often there is another and more important question which demands attention; namely whether its use unnecessarily increases the period of observation and delays the proper treatment. In certain of our cases this appears to have been the case though one hopes that the experience gained will prevent its repetition. On the other hand the gain in diagnostic certainty is such as more than to compensate for a possible delay in treatment. It also appears that the use of barium has given such definite evidence of ultimate improvement that a number of patients have been spared operative intervention. It must also be remembered that many cases of ileus have pre-operative treatment of rather long duration and this time may be used for repeated radiographic investigation. All in all we are on principle cautious in our use of oral barium and the indication ought to be discussed with the surgeon in each individual case. Quite otherwise, however, is the question of high obstruction. In such cases there may be very little gas in the small intestine as it so easily passes up into the stomach or is vomited up. Barium must often then be given in order to make the diagnosis of obstruction at all. The barium collects quite quickly in the affected upper jejunum and the site of obstruction is often seen more easily than in a lower obstruction.

Differential Diagnosis: The symptoms of ileus of the small intestine are in most cases so characteristic that a certain diagnosis can be made; there is, however, a number of conditions with occasional similar findings. Dilated loops of the small intestine with fluid levels are not in themselves pathognomonic signs as stated in the literature. In inflammatory conditions of various kinds, for example, hoop-shaped loops of bowel may be seen even though they have not quite the same appearance as those of ileus. Jejunitis and ileitis may be differentiated from mechanical ileus by definite signs. The distension of the loops is not then particularly marked; they are hoop-shaped but with uneven crenated borders due to the swelling of the mucosa. The barium is retained stuck to the intestinal wall up to 24 hours in the affected portion. In our 14 cases of radiologically investigated acute jejunitis there was always a certain amount of gas in the colon with fluid levels also. Many local inflammations such as appendicitis and salpingitis produce gaseous distension of the small intestine. At the same time there is nearly always gas and fluid formation in the caecum and ascending colon giving a picture of local peritonitis. If the intestines become adherent in an inflammatory process there arises a secondary obstruction in the form of kinking or twisting of the bowel with the development of a *mixed type ileus* (Fig. 8). The small intestinal loops become bowed with distension by gas and fluid but at the same time fragmented fluid levels and gas will be found in the colon. A *mechanical ileus of the large intestine* sometimes causes difficulties in differential diagnosis. If

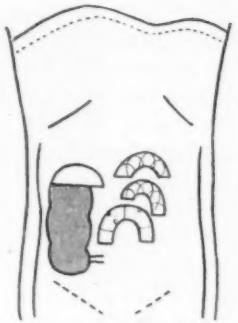

Fig. 9. Diagram to show principal findings in ileus of great bowel. Stenosis in colon transversum.

the obstruction is in the region of the caecum near the ileo-caecal valve, it is obvious that the picture will resemble that of ileus of the small intestine to the point of confusion. For a certain diagnosis, the obstruction must be situated sufficiently far from the opening of the ileum into the caecum, to enable the prestenotic portion of the caecum to fill with gas and fluid. In one case of our series there was nothing but fluid in the ascending colon so that the whole of this portion of the bowel presented as a tumour-like thickening. In our experience, the ileo-caecal valve is usually open in ileus of the large intestine so that the delay immediately communicates itself to the lowest portion of the ileum which then appears to be in a state of ileus. If one does not, therefore, see fluid levels in the colon, one may mistakenly diagnose the condition for one of ileus of the small intestine. One should not thus pay so much attention to the distended loops of small bowel as to overlook local changes in the colon. One may be sufficiently fortunate that a change in position brings a column of gas up against a tumour enabling it to be visualised without the use of barium. In the transverse colon there is nearly always gas proximal to the obstruction. The prestenotic portion shows in the upright position, a typical bowed shape with indentations along its contours corresponding to the haustrae, so it is comparatively easy to determine the site of the obstruction (Fig. 9). The portion of the colon distal to the obstruction is usually empty and one should accordingly determine the point separating distended from collapsed bowel. In the descending and sigmoid colon the site of obstruction is best determined in the right lateral position where the gas and fluid levels are drawn down into the left iliac fossa. It is often surprising how little the distal colon becomes distended compared with the proximal. In obstruction of the sigmoid colon for example, the caecum may be greatly distended while the descending colon perhaps may contain merely a few short fluid levels. On rare occasions such distension of the caecum leads to rupture and the radiological picture is one of combined pneumoperitoneum with ileus. Experience shows that rupture of the caecum occurs only in those conditions where the ileo-caecal valve is sufficient. Ordinarily one may say that diagnosis of ileus of the large intestine is easier when the ileo-caecal valve is closed. The gas and fluid is then limited to the large intestine so that there are no confusing findings in the small intestine. When the diagnosis of ileus of the large bowel is made in a flat film, the next question is of the localisation of the obstruc

tion. The patient must then, if his condition permits, be examined by barium enema; often carcinoma of the colon is the cause of the ileus and the surgeon can immediately plan the correct treatment. The demonstration of the tumour itself is often troublesome particularly when it lies in the region of the sigmoid colon or rectum. The tumour may obstruct the bowel contents and so produce a state of ileus and yet the barium enema may perhaps pass quite easily. One must not be deceived by this and it should be remembered that the obstruction behaves not infrequently like a valve allowing passage in one direction and not the other. Oblique films in different positions and lateral films of the rectum are needed to ensure the diagnosis. If the obstruction is complete, the tumour is often nicely shown at the junction of the column of gas with the barium of the enema. Of volvulus conditions one is chiefly concerned with *volvulus of the caecum* as regards differential diagnosis. This can produce quite marked gaseous distension of the small intestines but as a rule the distended caecum should put one on the right track. In cases of doubt a barium enema will decide the diagnosis (FRIMANN-DAHL). Volvulus of the sigmoid colon can occasionally be difficult to differentiate from ileus of the large intestine but this also a barium enema will decide.

Paralytic ileus is distinguished from mechanical ileus principally in that both the small and large intestines are affected. Because of the diminished peristalsis, the bowels are not definitely hoop shaped but are long and lax. Gas and fluid are retained in both portions of the gut and are uniformly spread according to the severity of the paralysis. In the colon the fluid levels are fragmented and are generally best seen in the left lateral position (Fig. 10). To the picture of *peritonitis* also belong signs of fluid between the intestines, obliteration of the extra-peritoneal layer of fat, together with lung changes in the form of fluid in the costophrenic angles and flat basal atelectases.

From the point of view of differential diagnosis, the greatest difficulty lies in the differentiation between a long-standing mechanical ileus and a paralytic ileus. The picture of peritonitis can be typical but the findings are not always such a sure criterion as those of mechanical ileus.

In the post-operative period roentgen examinations often yields good diagnostic evidence. The paresis then becomes particularly marked and may cause great distension of the small intestine. The distinction then between a mechanical and a paralytic ileus may be a problem. One must be prepared to repeat the investigation and observe carefully whether the amount of gas in the colon increases or decreases. Barium by mouth may be given if a partial obstruction is suspected (Fig. 11).

In *Mesenteric Thrombosis* the differential diagnosis is between an ileus of the small intestine and a peritoneal reaction. The roentgen findings in this condition are difficult to define correctly and the diagnosis of

Fig. 10. Paralytical ileus. Right lateral position. Rests of barium in colon show fluid levels without movements.

peritoneal irritation only may be made. Our series of eight cases of pure mesenteric thrombosis showed gas-filled loops of small intestine with fluid levels; gas and fluid were also found in the colon and especially on the righthand side, a finding which conforms to the suggestion that the superior mesenteric artery is that most frequently affected and that it supplies this corresponding portion of the bowel. All in all it must be admitted that the radiological findings are relatively scanty and are in a way, a contrast to the clinical and operative findings.

Radiological indications for operation. The indication for operation naturally cannot be determined upon the radiological findings alone and it goes without saying that it is the surgeon who must decide whether or not to operate. On the other hand the roentgenogram may be such a sure guide to the diagnosis that these findings must most certainly be taken into account in the assessment of the situation. Naturally the question arises therefore, whether radiological findings can be decisive. As a rule one may say that the typical radiological picture of a mechanical ileus makes it probable that the patient must be operated upon. There may however be other factors in the situation of which the radiologist is perhaps unaware. The condition may retrogress by itself, the patient may have had a former similar attack and so on. The radiological findings clarify the following points of importance to the surgeon.

1) *Which portion of the bowel is affected?* Ordinarily it is not difficult to differentiate between an ileus of the small intestine and that of the large intestine, by the appearance of the gas-filled loops: whether they have haustrae or circular rugae. Also the length of the fluid levels compared with the height and breadth of the columns of gas is of help while it is important to separate the areas corresponding to the positions of the small and large intestine respectively. In doubtful cases the difficulty is generally solved by the use of barium either orally or as an enema.

2) *The site of the obstruction* must be determined radiologically in most cases, and as regards ileus of the small intestine this is relatively

Fig. 11.

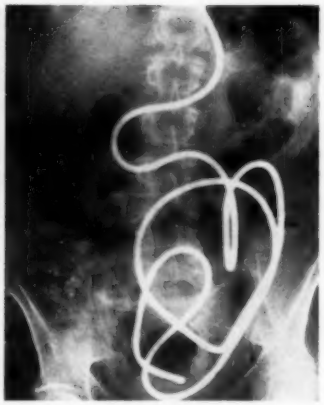

Fig. 12.

Fig. 11. Erected prestenotic loop shows stenosis of the lower ileum.
Fig. 12. The Miller-Abbott sound sucks up the gas from the prestenotic part of bowel.

easy. A precise localisation may perhaps be impossible but it can, for example, be stated that the obstruction lies in the ileum on the right-hand side inferiorly towards the pelvis. The difference between the ileum and the jejunum may often be seen by the depth and course of the mucosal folds. If only few loops are seen the interpretation is relatively difficult and especially when they are high up. The probability is that the obstruction is also high but this need not be the case. As mentioned before, the gas is drawn up, in the upright position, away from the stenosis and takes the loops with it. If there are found on the other side, numerous f uid levels down towards the right, then it is clear that the obstruction must lie comparatively low. Another sign, postulated by LAURELL, is that the prestenotic loops are generally particularly distended. They may also show a pronounced hoop shape (HØYER) and be markedly erect (Fig. 11). It is best to determine the site of the obstruction after barium when the site may be directly seen in many cases, especially in the colon but also in the small intestine. One cannot count on seeing adhesions but a hernia may perhaps be visualised whether it lies in the pelvis or is paraduodenal. Hernia of the abdominal wall is fairly easy to demonstrate radiologically; one can state the type of contents and also the possibility or otherwise of incarceration.

3) The stage of the condition can also be determined radiologically. Mechanical ileus, for example, shows a variable course and it is this which lends difficulty to the clinical diagnosis. After the first stage with its

severe pain and vomiting, there is not infrequently a period of remission with, perhaps, abundant passage of flatus and faeces while vomiting also may bring temporary relief. It is precisely at this period, when the patient himself possibly claims to be fairly well, that radiological investigation is of incalculable aid in that it demonstrates directly what is happening within the abdomen. Faecal masses may disappear and gas may possibly return to the colon but the gas and fluid levels proximal to the obstruction remain. The radiological evidence is then decisive and the patient is not lost sight of. He must either be operated upon or observed hourly.

4) Repeated examination may provide evidence of whether the condition is *deteriorating or improving*, and likewise an especially good basis for determining the indication for operation. Without the use of barium it is the rule that if the small intestine becomes more and more distended and the loops become more definitely hooped, this indicates an increasing degree of obstruction. The reverse holds if the distended loops become smaller and the amount of gas in the colon increases, pointing to a lessening of the degree of obstruction. Barium decides the question with ease and its passage into the colon indicates fairly certainly a partial obstruction only.

5) *Fluid in the peritoneal cavity* can as a rule be determined more easily radiologically than clinically especially when the bowel is abundantly filled with gas.

In many cases one can determine whether the amount of fluid is increasing or decreasing and this again is of great importance in deciding whether the patient is to be operated upon or not.

6) The picture of *true strangulation* with incarceration is a fairly decided indication of the necessity for immediate operation and it is therefore manifestly important that the radiologist should be able to make this diagnosis or at least direct suspicion towards it.

7) *Special* findings may be an *absolute indication for operation* such as obstructing faecoliths or gallstones for example. If, together with ileus of the small intestine, one finds a large gallstone and gas in the bile ducts, one has *a triad* that is pathognomonic of gallstone ileus and immediate operation is usually necessary.

8) When the patient is under observation prior to operation and is treated by aspiration with the Miller-Abbott tube as advised by WANGENSTEEN, this should be done under radiological control. The tube can in fact easily become curled up in the stomach and so be useless. At the same time it is important to notice also that this treatment sucks up the gas and fluid in the prestenotic portion of the bowel and the situation with regard to improvement or deterioration is accordingly more difficult to assess (Fig. 12). The »natural» contrast is then removed so that progress or regression may become impossible to estimate. Should this be so one

must inject barium through the tube in order to determine the degree of obstruction (RIEGLER, GOLDEN). We have relatively little experience of this special technique since an estimation is usually arrived at by means of the usual radiological methods either with or without barium.

9) In conclusion one must mention that a *negative* diagnosis is very often of invaluable support to the surgeon when it is a matter of withholding operation from a patient with acute abdominal symptoms. The radiological investigation may decide, for example, that the condition is not one of ileus at any rate; it may be either one of severe constipation with a secondary ileus or an enteritis and the clinical picture thus explained. In an occasional case one may perhaps find a *uretral calculus* as the cause of an ileus-like picture in which the loops of the small intestine may be filled with gas with a few fluid levels. In our series this picture has not lead to a misdiagnosis; in cases of doubt urography at once provides the solution. In *small children* with suspected ileus the abdominal findings have on several occasions been negative while the *systematic investigation* of the *thorax* has shown this to be the site of disease as, for example, a pneumonia. Similarly in adults such thoracic affections as pleurisy and cardiac conditions may be revealed as the cause of abdominal symptoms.

SUMMARY

Roentgen examinations of an intestinal obstruction give an exact diagnosis in most cases, and also show the ileus being a mechanical or a paralytical one. A combined ileus may be revealed in the same way. The seat of the stenosis is often seen on the survey pictures, and in the great bowel the nature of the hindrance diagnosed both directly and after a barium enema. It is possible to state an ileus of the small intestine very early. The roentgenological signs are outstanding also in a stage where the clinical symptoms are uncertain. In about 5 per cent of the cases of ileus of the small bowel, the findings are poor, but scrutinizing the films closer, they may, however, give holds for the diagnosis of a strangulating obstruction. An incarcerated loop gives more sparing symptoms than a simple obstruction. For the indications of an operative treatment, it is important to examine the patient repeatedly. The development both in progressive and regressive direction may then be followed. The differential diagnosis and other acute abdominal conditions are discussed.

ZUSAMMENFASSUNG

Röntgenuntersuchung einer Darmobstruktion gibt in der Mehrzahl der Fälle eine exakte Diagnose und zeigt ferner, ob der Ileus mechanischer oder paralytischer Natur ist. In der gleichen Weise kann ein kombinierter Ileus entdeckt werden. Der Sitz der Stenose ist oft in den Übersichtsbildern zu sehen, und im Dickdarm lässt sich die Natur des Hindernisses sowohl direkt als auch nach einem Bariumeinlauf feststellen. Ein Ileus des Dünndarms kann sehr früh erkannt werden. Schon in einem Stadium, wo die klinischen Symptome vieldeutig sind, treten die röntgenologischen Symptome hervor. In etwa 5 Prozent der Fälle von Ileus des Dünndarms sind die Befunde unbedeutend, geben aber bei näherer Untersuchung des Films Anhaltspunkte für die Diagnose eines Verschlusses durch Strun-

gu ation. Eine eingeklemmte Schlinge gibt geringere Symptome als eine einfache Obstruktio n. Zum Stellen der Indikationen für eine operative Behandlung ist es wichtig, den K nken wiederholt zu untersuchen. Man kann dann sowohl eine progressive als auch ei regressive Entwicklung verfolgen. Die Differentialdiagnose und andere akute Bauchfä e werden besprochen.

RÉSUMÉ

Les examens radiologiques des obstructions intestinales permettent un diagnostic ex t dans la plupart des cas, et montrent également si l'iléus est de nature mécanique ou paralytique. Un iléus combiné peut faire sa preuve de la même façon. Le siège de la sté ose se voit souvent sur les images d'ensemble, et dans le gros intestin la nature de l'o stacle est diagnostiquée tant directement qu'après lavement baryté. Il est possible de reconnaître très précocement un iléus du grêle. Les signes radiologiques sont marqués même à un stade où les symptômes cliniques sont incertains. Dans environ 5 % des cas d'iléus du grêle les signes sont peu apparents, mais en scrutant les films de plus près ils peuvent quand même fournir des arguments en faveur du diagnostic d'obstruction par strangulation. Une anse incarcérée donne des symptômes plus parcimonieux qu'une obstruction simple. Pour poser l'indication d'un traitement opératoire il est important d'examiner le patient à plusieurs reprises. Cela permet de suivre alors le cours du mal, en direction progressive ou régressive. Discussion portant sur le diagnostic différentiel et d'autres lésions aiguës de l'abdomen.

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AUS DEM RÖNTGENINSTITUT DR. MAX HOPF, BERN, SCHWEIZ

BEITRAG ZUM RELIEFBILD BEIM MAGENCARCINOM[1]

von

N. H. Krisnapoller

Alle, auch die klassischen Symptome des Magencarcinoms haben im Röntgenbild ihre Klippen, und es ist gut sie zu kennen, um Fehldiagnosen zu vermeiden. Dies gilt besonders für die Reliefveränderungen beim Magencarcinom, die als Frühzeichen eine grosse Bedeutung erlangt haben (BERG, FORSSELL, HAUDECK u. a.). Das Magenrelief hat schon unter normalen Verhältnissen wegen seiner Autoplastik ein so verschiedenes, oft trügerisches Gesicht, dass man bei der Beurteilung, in gewissen Fällen, das Normale vom Pathologischen kaum unterscheiden kann.

Die Faltenstarre und der Faltenabbruch am Tumorrand gehören bekanntlich zu den charakteristischen Reliefveränderungen des Magencarcinoms. Die expansiv wachsenden Krebse mit ihren umschriebenen, mehr ins Mageninnere vordingenden Wucherungen und die Übergangsformen führen rasch zu typischen Reliefveränderungen. Ausserdem exulcerieren sie oft und relativ früh. Durch zentralen Zerfall entstehen die bekannten schüsselförmigen Carcinome. Der Faltenabbruch ist für diese Typen der Geschwulstbildung kennzeichnend. Nur wenn die neoplastischen Erhebungen zufällig in der Längsrichtung der Falten verlaufen, können sie mit den letzteren verwechselt werden (BERG). Schreitet aber eine krebsige Infiltration submucös weiter und wird die noch intakte Schleimhaut unterwachsen, so können die Falten bei der Palpation noch deformierbar erscheinen. Die flächenhaft, infiltrierend wachsenden Carcinome können deshalb im Anfangsstadium die erwähnten Symptome vermissen lassen.

Eine andere Täuschungsmöglichkeit liegt nicht im pathol.-anatomischen Substrat des Geschwüres, sondern in den Projektionsgesetzen des röntgenologischen Summationsbildes, weil sich die Reliefbilder der Magenvorder- und Hinterwand im sagittalen Strahlengang übereinanderprojizieren. Bei der Durchleuchtung hat man allerdings die Möglichkeit durch Palpation die Magenwand zu verschieben durch Schräg- und Querprojektion die Vorder- von der Hinterwand zu trennen.

[1] Bei der Red. am 22. II. 1947 eingegangen.

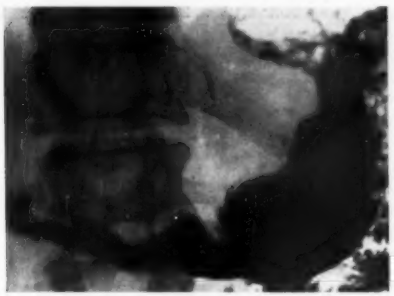

Abb. 1 a.

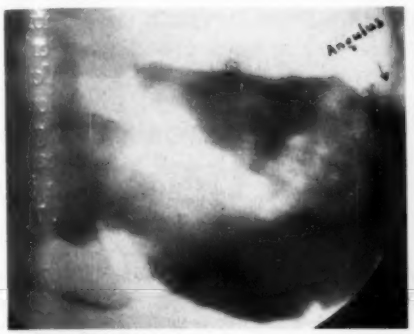

Abb. 1 b.

Abb. 1 c.

Abb. 1 a. Pat. H. E. geb. 1899. Schüsselförmiges Carcinom der Antrumhinterwand. Übersichtsbild.
Abb. 1 b. Zielaufnahme der Antrumgegend im Stehen bei leichter Linksdrehung.
Abb. 1 c. Zielaufnahme der Antrumgegend (nicht Bulbus d.) in Bauchlage.

Der nachfolgend, als Beispiel, beschriebene Fall bot keine diagnostischen Schwierigkeiten, scheint uns jedoch die zuletzt erwähnte Täuschungsmöglichkeit durch Summation besonders eindrucksvoll zu illustrieren: Im pylorusfernen Antrumabschnitt füllte sich schon bei der Reliefdarstellung ein dreieckiger, unregelmässig begrenzter Krater, der von einer fast 1 cm breiten Aufhellungszone umgeben war. Die verdickten Schleimhautfalten der Magenhinterwand brachen hier eindeutig ab. Die Zielaufnahme dieser Gegend in Bauchlage zeigte aber ein ganz anderes Bild (Abb. 1 c): Die Schleimhautfalten schienen gegen das dichte Zentrum des übermandelgrossen Kraters hinzulaufen und leicht zu konvergieren, während eine höher gelegene Falte kontinuierlich über das grosse Kontrastmitteldepot hinwegzog. Würde man die Diagnose nur auf dieses

Detailbild abstellen, so hätte man zur Feststellung eines chronischen Hinterwandulcus mit Faltenkonvergenz verleitet werden können. Die röntgenologische Gesamtuntersuchung sprach jedoch dagegen und das Reliefbild im Bauchlage musste dementsprechend gedeutet werden: Die vollständig intakten Falten der Magenvorderwand projizierten sich auf die Hinterwand über den Carcinomkrater, wobei sie im Zentrum des Kraters infolge grosser Schattendichte ausgelöscht wurden, um in den helleren Randpartien des Defektes wieder erkennbar zu werden. So liessen sich die scheinbare Faltenkonvergenz und die isolierte, über den Krater ziehende Längsfalte erklären. Es musste ein zerfallendes Carcinom der Magenhinterwand angenommen werden, weil auch die anderen Zeichen in dieser Richtung sprachen: Die Stufe an der Kleincurvaturseite, über die der Tumor leicht hinausragte; der breite Aufhellungswall; die lokale Starre bei der Palpation; Aufhören der Motilität im Tumorbezirk, wobei diese Partie von der angrenzenden, noch erhaltenen Peristaltik nur passiv mitgenommen wurde, und schliesslich die gute Verschieblichkeit des Antrums besonders beim Baucheinziehen. Ein Ulcus von dieser Grösse wäre mit grosser Wahrscheinlichkeit penetrierend gewesen und deshalb nicht frei beweglich. Ausserdem sind grosse Ulcera in der Antrumgegend eine grosse Seltenheit. Darauf habe ich schon in meiner Arbeit über das grosse Magengeschwür (Gastroenterologia Vol. 71, Fasc. 3, 1946) hingewiesen.

Der Operationsbefund (P. D. Dr. SAEGESSER) und die pathol. anatomische Untersuchung bestätigten das Vorhandensein eines schüsselförmigen Carcinoms der Magenhinterwand, welches frei beweglich war und, nebst einigen kleinen Drüsenmetastasen in der Nachbarschaft, gut reseziert werden konnte.

ZUSAMMENFASSUNG

Hinweis auf die projektionsbedingten Täuschungsmöglichkeiten (Summation, Superposition) im Magenreliefbild bei Magencarcinom, an Hand eines radiologisch und operativ gesicherten Falles.

SUMMARY

Reference to the possibilities of error (summation, superposition) determined by projection in a relief picture of the stomach in carcinoma of the stomach based on a radiologically and operatively verified case.

RÉSUMÉ

L'auteur rend attentif aux possibilités d'erreurs dues à la projection des images (sommation, superposition) dans l'interprétation du dessin du relief de l'estomac lors de carcinome de cet organe, en se basant sur un cas vérifié radiologiquement et opératoirement.

FROM THE NEUROLOGICAL AND THE RADIOLOGICAL DEPARTMENTS OF RIKSHOSPITALET AT OSLO (PHYSICIAN IN CHIEF: G. H. MONRAD-KROHN, M. D., PROFESSOR OF MEDICINE, AND T. DALE, M. D., PROFESSOR OF MEDICINE)

ENCEPHALOGRAGHY WITH SMALL AMOUNTS OF AIR[1]

by

Kristian Kristiansen and *Agvald Vogt*

In 1929 and 1931, LARUELLE in Brussels described a method for the examination of the ventricles of the brain, which he called repérage ventriculaire (repérer = to earmark). The method entails the injection of 10 cc of air into the subarachnoid space by spinal puncture, whilst the patient is in sitting position, the air thus passing through the 4th ventricle into the lateral ventricles. LARUELLE generally injected 10 cc of air, sometimes 5 cc, and very rarely 15 cc.

Originally he injected the air very slowly, but later arrived at the conclusion that the air probably passed more easily into the ventricular system if he made a rapid injection with 5 cc at a time.

LARUELLE's intention with this method was to test firstly as to whether the spinal fluid channels were open; and secondly as to how the lateral ventricles were placed, or their possible displacements; and thirdly if there were any differences in the size of the two lateral ventricles.

He pointed out that his method was not an ordinary encephalography or ventriculography, which aims at a complete filling of the ventricles with air, resulting in a detailed roentgen picture of the shape, size and location of the ventricles.

LARUELLE mentions the objections which can be brought up against his method. The one is that the air does not find its way into the ventricular system. This occurred in 5% of his first 200 cases. If on the second injection the air did not find its way into the ventricles, he thought that this must mean an obstruction somewhere between the subarachnoid space and the lateral ventricles. Another objection was that the two ventricles can receive varying amounts of air. If this difference is not equalised when the patient is lying on his side with originally the lesser

[1] Submitted for publication July 1, 1946.

filled ventricle uppermost, this was interpreted as an obstruction in the 3rd ventricle or foramen of Monro.

LARUELLE accentuates the practicability and safety of this method in comparison with the intricate arrangements necessitated for a ventriculography or a complete encephalography, and also gives examples of successful diagnoses of location.

It seems to appear from LARUELLE's description that the method is safe also in cases with tumors in the posterior fossa, and he concludes that it is routine method in his department for the examination of all patients with cerebral diseases. As a comparison he mentions the death rate caused through the ventriculography, and the big encephalographies, and the very great inconveniences to which the patient is subjected through the ventriculography.

LARUELLE stresses also that if necessary for the diagnosis there is no objection to making a ventriculography or a large encephalography, if the result has not been reached through the use of 10 cc of air.

LARUELLE's method was soon taken up by the Neurological Department of the Rikshospitalet (Norwegian State Hospital) in Oslo. A brief announcement made by MONRAD-KROHN in the Norwegian Society of Medicine in December 1933, discusses the advantages of LARUELLE's method and described the way in which Rikshospitalet applied this system.

With the patient in sitting position a spinal puncture was performed with a fine needle. 5 to 6 cc of spinal fluid was slowly removed, and afterwards 5 cc of air rapidly injected. Then again 5—6 cc of fluid was removed and a new portion of 5 cc of air injected.

2 hours before the encephalography the patient received an intravenous injection of hypertonic dextrose solution or a magnesium sulphate enema.

This method requires a long series of roentgen pictures as the small amount of air must be directed to the various parts of the ventricular system through different positions of the head.

During two years in all 183 encephalographies were performed by this method, with two deaths possibly caused by the examination. MONRAD-KROHN concludes that it is a fair relation between the trouble and the danger which the patients are subjected to, and the result of the method.

Since this publication, LARUELLE's small encephalography has been applied by the Neurological Department continually until the last years. The details of the method have been varied, and during the years 1940—43 the usual procedure was to remove 4 cc of spinal fluid and inject 3 cc of air, three alternating times. The amount of air used during these years was 9 cc. In the cases of bad filling of the ventricular system, a new encephalography was performed some days later (similar to the above

method), this being repeated three or four times if necessary. In those cases a little more air was usually injected, totalling 12 or 15 cc (3 cc × 4 or 5).

From the perusal of the foreign literature on encephalography and encephalographic techniques, it appears that this small encephalography has not been used in other clinics as a routine method.

Of more important works from the last years can be mentioned BOHN's analysis, published in 1937, of the reaction after encephalography in 1,000 patients. The average amount of air injected in these cases was 68.79 cc. It is of interest in this connection that only 10 % of the 1,000 encephalographies showed unsatisfactory filling of the ventricular system if the material was considered as a whole, as compared with incomplete filling in 26 % of the cases with intracranial tumor. BOHN emphazises that the duration of the patients' symptoms after encephalography seems to be directly proportional to the amount of air used in injection. Similarly, patients with atrophy of the brain appeared to have the shortest duration of symptoms, a common experience which demonstrates that the duration of the reaction is proportional to the amount of air used relative to the capacity of the cerebrospinal fluid spaces.

In BOHN's work he describes two deaths attributable to the encephalography, both of patients with intracranial tumor.

DAVIDOFF and DYKE's monography on the normal encephalogram, of 1937, is based on their experience with 4,000 cases. They attempted to determine the optimum amount of air needed in each case, and have concluded that 50 to 70 cc of air is sufficient for the patients with approximately normal size of the ventricular system. Patients with large ventricles require more air to give pictures satisfactory for diagnostic purposes. DAVIDOFF and DYKE always performed the encephalography with the patients in position to be radiographed, and took a film after 25 cc of fluid had been removed and 20 cc of air injected. After judging the ventricular filling by means of this film, they then injected the amount of air that experience had proved necessary to give a satisfactory encephalography.

Through the past years several manipulations of the patients' head *e.g.* nodding, during the injection of air have been tried, all based on the assumption that the air should either be sucked into the fourth ventricle, or that bubbles of air sticking in the aqueduct of Sylvius should be released and proceed into the third ventricle and the lateral ventricles. The assumptions are to a large extent theoretical, and are probably not founded upon the real facts. Considering the rapid movement of the air from the spinal canal into the lateral ventricles, as is observed on the fluoroscopic screen during the injection of air, it is improbable that any movement of the patient's head will affect this air passage.

It has been noted that when the patient hears a bubbling sound during the injection, it is an indication that the air has reached the lateral ventricles. Our experience tends to show that this assumption is not based on actual facts either.

As the encephalograms with small amounts of air performed in the Neurological Department seemed to give unsatisfactory diagnostic results, in 1942 we selected a representative group consisting of 100 patients from the Department, in whom a small encephalography ad modum LARUELLE had been performed.

The quantity of air used in the first encephalography of the above-mentioned patients was always 3 cc × 3, totalling 9 cc.

Observations have also been made of the 2nd and 3rd encephalograms, but only when injecting 9, 12 or 15 cc of air. The same applies if it is necessitated to attempt 4th or 5th encephalography in the same patient, when 9, 12 or 15 cc is also used.

To decide whether the ventricular system is filled to satisfaction or not is a matter of opinion which may vary in different clinics. In estimating it from both a neurological and a radiological point of view, we thought it possible to get a solid foundation for the conclusion in each case.

Each record of every patient was examined accurately to ascertain whether there were any circumstances which could exert influence on the ventricular air filling. Facts from the case history, neurological and other clinical signs, cerebrospinal fluid findings and the technique of injection were noted in every case and compared with the results of the encephalography. The roentgen pictures in all projections were studied and the air filling transferred to diagrams of the cerebral ventricles as seen in antero-posterior, postero-anterior and lateral views. Also projection with the tube at an angle of 35° cranially was studied.

The types of air filling were divided into the following groups.

1. *No filling.*
   No air is seen in the ventricular system, although some air may be found in the subarachnoid space.
2. *Incomplete filling.*
   Air is seen in the lateral ventricles, but is insufficient for diagnostic purposes. In lateral view, with the patient in supine position, the anterior horns are seen to be filled or only partially so and cannot be traced farther backwards than the second ventricular portion (TORKILDSEN's and PENFIELD's terminology, see figure).
   Also a small air bubble may be seen in the third ventricle.

3. *Good filling.*

The amount of air gives a serviceable base for diagnosis. Some of these cases are questionable and might as well be placed in group 2 above, but in order to give the method an opportunity, we have included these doubtful cases in the group of good fillings.

The Material: 100 patients admitted to the Neurological Department from January to July 1941, were selected continuously after their serial number. No other method of selection has been practised, the material thus gives an average picture of the small encephalographies performed at the hospital ad modum LARUELLE.

Table 1.

Age and sex distribution.

Age Distribution.	Number
Children 0—15 years	17
Adults 16—50 years	74
Elderly Adults 50—70 years	9
Total	100
Sex Distribution	
Females	60
Males	40
Total	100

Table 2.

Diagnoses.

Cerebral arteriosclerosis	1
Headache	6
Hypertensive encephalopathy	2
Epilepsy	25
Subarachnoid Hemorrhage	3
Hemiparesis et al.	5
Meningitis	1
Heredo-ataxia et al.	7
Trigeminal neuralgia	1
Neurosis and psychosis	6
Paralysis agitans et al.	9
Disseminated sclerosis et al.	8
Post-traumatic syndromes	13
Intracranial tumor	13
Total	100

With such a heterogeneous material, difficulties will be met when trying to decide whether the air filling is particularly defective in certain diseases, although some indication may be obtained.

Technique of Injection

The patient is seated on a bench with the head resting in the hands of an assistant. A lumbar puncture is performed, and after removal of 4 + 4 + 4 cc of spinal fluid 3 + 3 + 3 cc of air is alternatively injected. Immediately after the injection of each portion of air the assistant is making a nodding movement of the patient's head, backwards and forwards. The patient is asked to indicate if he hears a bubbling or rippling sound during the passage of the air. This sign has been taken as evidence that the air is passing the Sylvian aqueduct, but this theory cannot be confirmed from our own experience. The bubbling sound may not be apparent when the air is filling the ventricles, and may be present when there is no trace of air in the ventricles.

If the encephalography has to be repeated, 3 × 3, 4 × 3 or 5 × 3 cc of air is injected again, and if desired the third and fourth attempts of 4 × 3 cc or 5 × 3 cc may be used.

In certain cases, namely 23 of the 100 patients, a larger amount of air was used at the second or following encephalography. In the course of 27 encephalographies on the 23 patients, between 20 and 90 cc of air was used, 30 cc or less being used in 10 of these.

Results

Altogether 162 small encephalographies were performed on 100 patients. The air filling of the ventricular system in the 100 cases examined is distributed among the different groups as follows:

Table 3.

Results of filling in 162 small encephalographies.

		Degree of Filling.		
		No Filling.	Incomplete.	Good.
1st encephalography	(9 cc of air)	16	73	11
2nd »	(12 or 15 cc of air)	12	29	5
3rd »	(12 or 15 cc of air)	4	6	0
4th »	(9, 12 or 15 cc of air)	2	3	0
5th »	(9, 12 or 15 cc of air)	0	1	0

At the first attempt only 11 % of the 100 patients showed a quantity of air in the ventricles sufficient for the diagnoses. 73 % were incomplete and in 16 % there was no air at all in the ventricular system.

A second attempt in 46 of the 100 patients produced a further 5 cases with suitable filling for diagnostic purposes. In the third, fourth and fifth attempts with a few patients no encephalography was successful, even when using 12 or 15 cc of air.

This proves that a number of our patients were discharged from the hospital without having fully utilised the diagnostic possibilities of modern neuro-radiology.

We are aware that it may be justifiable to say that in some cases the encephalogram, even with incomplete quantity of air *suggests* normal conditions, but there are also numerous cases where abnormalities have been overlooked on account of too little air.

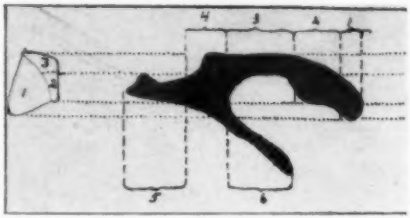

Fig. 1. The portions of the lateral ventricle (after TORKILDSEN and PENFIELD).

Below is given a short record of two such cases:

1. *Serial No. 2233/45. K. J. male*, 19 years of age, was admitted to the Neurological Department of the State Hospital in Oslo on 10th March, 1944. He was discharged three weeks later with the diagnosis cryptogenetic epilepsy. Encephalography was performed three times with 15, 15, and 30 cc of air, each time with incomplete filling (fig. 2). He was again admitted to the hospital in August last year, when an encephalography with 60 cc of air showed the following result: »Good filling of the lateral ventricles, with partial filling also of the 3rd ventricle. Abundance of air in the subarachnoid space. An air-filled cavity of the size of an egg is seen in the right hemisphere in connection with the anterior horn of the right lateral ventricle. This may cause a slight shift of the ventricular system to the left.»

R: Porencephaly in the right frontal lobe. (Signed ENGESET) (fig. 3).

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

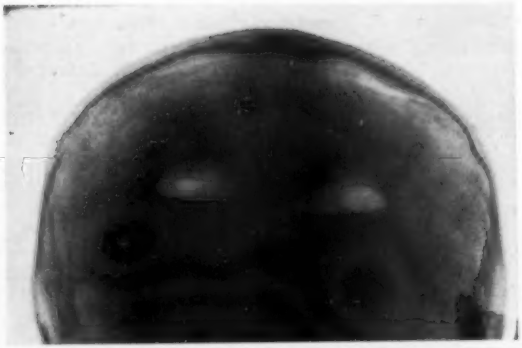

Fig. 7.

2. *Serial No. 12727/46. E. L., male,* 42 years of age, has recently been examined in th hospital on account of steadily increasing headache during the last year. A small er ephalography with 15 cc of air shows a little air in the right anterior horn which seems to be displaced to the right (fig. 4 and 5).

A second encephalography before the roentgen screen was made. After injection of 40 cc of air by the lumbar route, satisfactory filling was not obtained, and a cisternal pu cture with insufflation of air was then performed during the same sitting. As a result we found a big subtentorial cavity suggesting a cerebellar dysplasia. The cavity was in di ct communication with the posterior part of the enlarged lateral ventricles. There was als evidence of cortical atrophy (fig. 6 and 7).

The two above mentioned cases prove that the correct amount of air ne essary for the diagnostic purposes should be used in every case.

Some of the more important facts from the patients' history and clinical findings were compared with the degree of ventricular filling, to be able to estimate their possible significance on the result of the encephalography. Although the figures are small, they may be used as a guidance.

30 cases, comprised of patients with intracranial tumors, post-traumatic states, subarachnoid hemorrhage and meningitis, showed ventricular filling of air as follows:

Table 4.

Ventricular filling in 30 cases with gross intracranial lesions.

	Number
No filling	7
Incomplete filling	23
Good filling	0
Total	30

These figures may indicate that cerebral lesions with marked alterations of the meninges or of the intracranial pressure will impede the passage of air from the subarachnoid space into the lateral ventricles.

On the other hand, the presence of pathological spinal fluid findings does not seem to influence the degree of filling. The limit of normal cell count and protein content is deliberately taken as 10/3 cells, albumen 1:20 and globulin 1 : 2, as measured by BISGAARD's method. Of the 100 cases 55 had a normal spinal fluid, and 45 pathological findings.

The distribution of the different degrees of air filling was as shown in the following table:

Table 5.

Ventricular filling in relation to spinal fluid findings.

	No filling	Incomplete	Good
55 patients with normal fluid	8	40	7
45 patients with pathological fluid	8	33	4

14 patients with clinical or roentgenological signs of increased intracranial pressure showed no filling in 3 cases and incomplete filling in 1 cases; none of them presented good filling.

As a contrast it may be mentioned that all 11 cases mentioned in table 3 showing good filling in the first attempt, had normal encephalograms.

The diagnostic difficulties for the Roentgen Department are undoubtedly present when small encephalographies are used. This drawback would perhaps be possible to overcome if the method was assuredly without danger. This is not the case. If the patient is running a risk when subjected to a large encephalography, there will also be a risk in performing a small one.

The following three cases from the Neurological Department demonstrate this fact:

1. *Serial No. 6705/38, J. K., male,* 46 years of age, admitted on the 29th January 1938, died 3rd February 1938.

Diagnosis: Intracranial tumor. The optic discs were not quite normal, but not definitely choked. A small encephalography, ad modum LARUELLE, was performed on the 31st January, 1938. The 3rd February is noted as follows: »The patient's condition is conspicuously worse. Yesterday partly comatose with shallow respiration.» A ventriculography was performed the same day, but a few hours later the respiration ceased. A ventricular puncture improved the condition a little, but he died the same evening.

Post mortem examination showed a tumor in the right fronto-parietal region, with a pressure groove in the left cerebral peduncle.

2. *Serial No. 6129/38. J. F., male,* 40 years of age, admitted 10th January 1939, died 22nd January 1939. Diagnosis: Glioma of the right frontal lobe. Bilateral papilledema.

A small encephalography was performed the 19th January. In the afternoon the same day the patient lost consciousness with cyanosis and slowing of the pulse rate. A right osteoplastic craniotomy performed in the evening showed the frontal lobe filled with a large tumor mass containing an abundance of fresh blood clots. He died three days later without recovering consciousness.

3. *Serial No. 1343/45, B. V., female,* 42 years of age, admitted 3rd August 1945, died 17th August 1945. Diagnosis: Intracranial tumor. Normal eye fundus.

A small encephalography with 3×5 cc of air was performed on the 8th August. Immediately afterwards the patient partly became confused, complained of headaches and vomited. She died on the 17th August.

The post mortem examination revealed a soft tumor, with a blood filled cystic structure in the left parietal lobe. Microscopic examination showed glioblastoma multiforme.

A definite advantage associated with the small encephalographies is that the patient's sufferings, especially the headache, are less pronounced than when larger amounts of air are used (BOHN). This is counterbalanced by the fact that the small encephalographies so often have to be repeated. The patients undoubtedly prefer *one* examination,

even if a little more troublesome, than to be subjected to many unsuccessful attempts.

It can happen also when using larger amounts of air, that the ventricular system is not filled or is incompletely filled.

Amongst 27 later encephalographies in this material using between 20 and 90 cc of air, 9 showed no filling at all, 5 incomplete filling and 13 good filling. The result would probably have been more satisfactory if a little more air than 20—30 cc had been injected in some of the cases.

On account of the unsatisfactory experiences with the small encephalographies as suggested by LARUELLE, we at the Neurological Department are now changing to other methods.

Even so we are still continuously using 15—20 cc of air in the first attempt, but if the result is not satisfactory we are making the next encephalography under roentgen control, and injecting the amount of air which seems to be required to give a filling satisfactory for diagnostic purposes.

The radiologist who performs the roentgenoscopy during the injection of air, gets a good impression of the ventricular filling after the injection of 20—25 cc, and later, if desired, 40—50 cc of air. The injection is then discontinued, and according to our experiences 40—60 cc of air is sufficient in most cases. If no air is seen in the ventricles after the insufflation of 40 cc, it is as a rule of no use to attempt further insufflation.

The examination is then postponed and a new attempt is made a week later. In cases where the lumbar insufflation has not been successful, we have sometimes succeeded in filling the ventricular system by injecting the air in the cisterna magna after suboccipital puncture. We are not using this method as a routine procedure, as is practised in some other neurological clinics.

If intracranial tumor is suspected we do not perform a lumbar or suboccipital insufflation of air, but perform a ventriculography, if the cerebral angiography is not giving a definite result as to the size and position of the tumor.

Owing to the pressure of work on the Roentgen Department of the State Hospital, we have not yet succeeded in carrying out what we find to be the rational procedure in encephalography, *i. e.* in all cases to perform the encephalography under roentgenoscopy. This would mean a great step forward towards effective diagnosis, significant economical saving owing to less film consumption, and a better utilisation of the valuable beds of the State Hospital.

SUMMARY

In the Neurological Department of the Rikshospitalet in Oslo LARUELLE's small encephalography has for many years been the routine pneumographic method. The diagnostic results have not been satisfactory, the ventricular system being insufficiently filled with air in the majority of cases. Nor is a small encephalography completely devoid of danger for the patient. The authors recommend as a rational procedure to perform all encephalographies under *roentgenoscopy*, 40 to 60 cc of air being sufficient in most cases.

ZUSAMMENFASSUNG

In der Neurologischen Abteilung des Reichskrankenhauses in Oslo stellt LARUELLE's kleine Enzephalographie seit vielen Jahren die pneumographische Routinemethode dar. Die diagnostischen Ergebnisse sind nicht befriedigend gewesen, indem sich das Höhlensystem in der Mehrzahl der Fälle ungenügend mit Luft gefüllt hat. Auch ist die kleine Enzephalographie für den Kranken nicht völlig ungefährlich. Als zweckmässiges Vorgehen empfehlen Verff. die Vornahme aller Enzephalographien unter *Röntgendurchleuchtung*, und zwar genügen in der Mehrzahl der Fälle 40—60 ccm Luft.

RÉSUMÉ

Dans le Service de Neurologie de Rikshospitalet en Oslo la petite encéphalographie selon LARUELLE (le repérage ventriculaire) a été la méthode pneumographique de routine depuis plusieurs années. Les resultats diagnostiques n'ont pas été satisfaisants. Le système ventriculaire fut insuffisamment rempli d'air dans la majorité des cas. La petite encéphalographie n'est pas non plus absolument exempt de danger pour le malade. Les auteurs recommandent comme un procédé rationel l'exécution de l'encéphalographie sous *l'écran radioscopique*. Quarante—soixante cc de l'air suffisent dans la majorité des cas.

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THE TREATMENT OF LYMPH NODE METASTASES FROM INTRA ORAL CARCINOMAS WITH SPECIAL REGARD TO THE INDICATIONS FOR TOTAL NECK DISSECTION[1]

by

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The method of treating cervical lymph node metastases has for a long time been a matter for investigation by the radiologists. The literature published on this subject is immense. From the Norwegian Radium Hospital has during a number of years been produced several works by BJARNE DAHL, HEYERDAHL and in particular by the hospital's present chief, ROLF BULL ENGELSTAD. In his latest work completed in 1945, BULL ENGELSTAD comprehensively discusses the complete material of total neck dissections performed at the hospital during the years 1932—1944 inclusive.

The present work is intended to enlighten the indications and contra-indications in the treatment of lymph node metastases from carcinomas in the true oral cavity. These as a rule are of the highly differentiated type. Particularly there has been a question whether prophylactic lymph node dissection ought to be used in certain of the intra oral carcinomas which have been submitted for treatment. In a country with Norway's geography — its long distances and strenous and expensive journeys for the patients attending frequent medical control examinations — this question is naturally more important than in a cancer clinic serving the needs of the population of a town.

The treatment of the regional lymph node areas has to be considered in connection with the treatment and the prognosis of the primary lesion. This again depends on the localization of the tumor and its relation to the neighbouring organs, its size and, not the least, its histology as well as its tendency to and method of spreading. In spite of a number of

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minor differences, all the intra oral carcinomas come in a somewhat identical group, and can, with advantage, be discussed in the same connection. Lymph node metastases from these types of tumors constitute approximately half the number of all cervical lymph node metastases. In examining 500 cases of cercival metastases HAYES E. MARTIN evolved the following analysis of the location of the primary tumor:

Tongue	127 (25 per cent)	Extrinsic larynx	44 (9 per cent)
Floor of the mouth	44 (9 » »)	Nasopharynx	40 (8 » »)
Mucosa of the cheek	28 (6 » »)	Lip	35 (7 » »)
Jaws	27 (5 » »)	Tonsil	34 (7 » »)
Palate	20 (4 » »)	Pharyngeal wall	24 (5 » »)
In all	49 per cent	Skin of the face	11 (2 » »)
		Thyroid	11 (2 » »)
		Miscellaneous	27 (5 » »)
		Undeterminated	28 (6 » »)

Re-examining our material we have taken into consideration only the types of tumors specified in the first column, the carcinomas of the true oral cavity. Carcinomas of the lips are not included as these, on account of the primary tumor's good prognosis and moderate metastatic tendency, come in a special group between carcinomas of the skin and the oral cavity. Carcinomas of the tonsils also come in a special group between the oral cavity and the pharynx and they also will not be discussed here. We find, however, that it is advisable to include carcinomas of the basis of the tongue despite the fact of their greater malignancy and metastatic tendency compared to all other carcinomas of the oral cavity and also, their clinical resemblance to carcinomas of the tonsils.

During the last twenty years the progress of radiation therapy as well as the increased knowledge of the histological grade of differentiation of the malignant tumors and its sensibility to irradiation, have led to a number of tumors of the mouth, nose and pharynx and their cervical metastases now being treated almost exclusively by radiation therapy. For practical reasons C. L. MARTIN divides cervical lymph node metastases into two groups:

1. Metastases from carcinomas of the pharynx, tonsils and basis of the tongue: »These no longer are cases for surgery but are treated almost exclusively by radiation therapy.»
2. Metastases from skin and lip carcinomas as well as carcinomas of the true oral cavity.

The second group is as a rule metastases from highly differentiated squamous cell carcinomas, while the first group more often is metastases from less differentiated squamous cell carcinomas, transitional cell carcinomas, lympho-epitheliomas as well as reticulosarcomas and lymphosarcomas.

As for the chances of cure in the early metastasizing highly anaplastic tumors, H. E. MARTIN writes that these »have been so much improved by the advent of modern radiation therapy as to approach the results by surgery in the highly radioresistant and slowly metastasizing tumors such as cancer of the lip». A manifest metastasis from the highly differentiated carcinoma in the oral cavity is on the other hand so resistant to radiation that only surgical treatment, that is, total block dissection ought to be considered where the tumor is operable. Nobody will disagree with this; it is only the particular indications and contraindications for total block dissection which are subject for discussion.

I refer to BULL ENGELSTAD's work of 1945 in regard to the topography of the normal lymph nodes of the neck, the course of metastases in carcinomas of the oral cavity as well as the surgical technique for total block dissection, originally outlined by CRILE and MORESTIN and further developed by ROUX-BERGER and his co-workers.

In the following discussion »neck dissection» is interpreted only as total block dissection ad modum ROUX-BERGER. Metastases from carcinoma buccae spread as a rule similarly to lip carcinomas; first to the submental and submandibular lymph nodes. It can therefore be justified to limit the operation to an upper neck dissection as described by RAYMOND BERNARD and others. As a rule, however, we use total neck dissection only because this is an operation which, provided the proper surgical technique and cautious indications are observed, has a low mortality and leaves little chance of recidivation. The same applies to other carcinomas of the oral cavity.

It would take too much space to repeat the whole development of surgical treatment of cervical lymph node metastases, but reference must be made to two stages in the process.

Based on the works by BUTLIN and that by CRILES a few years later, complete unilateral and bilateral neck dissection has for more than 25 years been the method of procedure in most American and many European clinics and has been applied to all cases, whether nodes were absent, or present and operable, or in an advanced stage of disease. During this period the only variation in the surgical treatment has been the sequence in the care of the primary tumor and the regional lymph nodes. It is now agreed that there is no necessity to treat the regional lymph nodes before the primary tumor, but up to the time of the last world war, a number of clinics still carried on with this treatment (BAENSCH-PAYR). Clinical experience regarding the frequency of lymph node metastases as well as pathological, anatomical and experimental results, all show that lymph nodes serve as a barrier against the spreading of cancer and it is therefore not logical to remove these before the primary lesion is treated.

As the procedure and possibilities of radiation therapy have developed, the trend in most clinics has been to treat the regional lymph nodes in intra oral carcinomas in a conservative way. The only exception is Institut du Radium in Paris where, especially in cancer of the tongue, prophylactic neck dissection is always done as soon as possible after the primary tumor has been removed: unilateral, or bilateral if the tumor has spread beyond the midline of the oral cavity. Their reasons for doing this are as follows: »L'histoire de ces petits épithéliomas linguaux, sans retentissement clinique sur les ganglions et que l'on abandonne sans traiter les aires ganglionnaires, est classique et lamantable: les malades reviennent le plus souvent porteurs de masses ganglionnaires développées avec une rapidité foudroyante; presque toujours, il se présentent dans de mauvaises conditions d'opérabilité . . . C'est pourquoi nous nous permettons d'y revenir et d'insister sur la nécessité de ce traitement dans tous les cas, sauf très rares exceptions.» (J.-L. ROUX-BERGER et A. TAILHEFER).

Contradicting this, D. QUICK at Memorial Hospital in New York wrote as early as 1921: »The routine block-dissection of the neck in practically all cases of intra oral carcinoma as generally accepted at the present time, is a frantic effort without regard for sacrifices and does not recognize either the natural history of the disease or the various factors which may modify it in individual cases.» Later on has from the same hospital been published a number of works which very convincingly prove the advantage of a strictly conservative treatment of cervical lymph node areas (D. QUICK, J. J. DUFFY, HAYES E. MARTIN and others). At the same time the procedure of interstitial treatment with radium and golden radon seed (FAILLA) appears to be a success, and may leave patients with inoperable lymph node metastases free from symptoms for a period of 5 years. This method also seems to make it possible to restrict the indications for total block dissection of the lymph nodes. There is, however, no doubt that total block dissection is a far more certain method in operable lymph node metastases. In reference to this J. J. DUFFY finds a freedom of symptoms over a period of 5 years in 20 per cent of cases following surgical treatment while only 7.4 per cent after interstitial application of radon.

J. J. DUFFY attaches special importance to the indications and contraindications for total neck dissection. These are as follows: Neck dissection is indicated when:

1. Primary lesion is controlled
2. » » » limited to one side of the oral cavity
3. » » » shown to be of highly differentiated cell type
4. Cervical metastases are present and limited to one group of nodes in two contiguous cervical triangles.
5. Capsule of nodes is not infiltrated by carcinoma

6. Opposite side of the neck is free of metastases
7. No distant metastases are present
8. Patient is in good general condition.

Neck dissection is contraindicated when:

1. Primary lesion is uncontrolled
2. » » extends to or beyond the midline of the oral cavity
3. » » is shown to be of undifferentiated cell type
4. No metastatic nodes are present
5. Capsule of the node is infiltrated by carcinoma
6. Cross or bilateral cervical metastases are present
7. Distant metastases are present
8. Patient is in poor general condition.

The indications used in The Norwegian Radium Hospital will be discussed later. They are on the whole the same as those stated by J. J. DUFFY although in certain cases a wider range of indications has been used. For instance, we do not consider it to be a contraindication for neck dissection when the tumor extends beyond the midline of the oral cavity as long as the primary lesion can be controlled. This applies, however, particularly to cases where, 8 weeks after the termination of radiation treatment metastases show more or less fixation. In these cases we are apt to extend the indications as far as possible in order to give the patient a chance by surgical treatment.

The results of palliative external radiation treatment of cervical metastases are outside the subject of this discussion. We shall only mention that it is generally agreed that external roentgen irradiation alone does not cure manifest metastases from highly differentiated squamous cell carcinomas. It is our experience that they react far better to treatment with teleradium, but as we have used aspiration biopsy systematically only during the last few years, we have not yet got histologically verified material covering a sufficiently long time of observation.

The Norwegian Radium Hospital's Material

This comprises all histologically verified cases of carcinoma oris treated in the hospital during the 10-years period 1932—1941, 386 patients all told. Although the control examinations cover the comparatively long period of 10 years, the material is rather identical as to treatment because neither methods nor indications followed have undergone particular changes during these years.

Classification of the Material

The apportions of the various localizations in the oral cavity are detailed in Table I. In this table the individual groups of tumors and the

total material are divided in the usual 3 stages according to the presence and extent of lymph node metastases and regardless of the size of the primary tumor.

Stage 1: No clinical symptoms of lymph node metastases.

Stage 2: Clinical metastases, limited and operable.

Stage 3: Lymph node metastases
- a) with commencing fixation
- b) with infiltration into the surrounding structure
- c) bilateral, operable or inoperable.

No satisfactory classification, which at the same time takes into consideration the size of the primary tumor with its operability and possible radio-curability has yet been found. We find the classification proposed by SCHINZ too complicated. It divides the material so much that the individual groups are too small to give a clear picture of the whole.

Table 1.

	Total	Stage 1	Stage 2	Stage 3
Free part of the tongue	84	50 (65.5 per cent)	18	11
Base of tongue	61	35 (57.4 » »)	10	16
Floor of mouth	55	24 (43.6 » »)	9	22
Ca. buccae	69	38 (55.0 » »)	14	17
Ca. gingivae	66	33 (50.0 » »)	20	13
Ca. palati	51	39 (76.5 » »)	7	5
Total	386	224 (58.0 per cent)	78	84

Histological Examination

Having gained the necessary experience, The Norwegian Radium Hospital has adopted BRODER's method of classification for an increasing number of tumor groups. For the squamous cell carcinomas this classification has not yet been put into practice and we therefore grade these types of tumors as we have hitherto done:

1. Highly differentiated cornifying squamous cell carcinoma with prickle cells and epithelial pearls.
2. Cornifying squamous cell carcinoma.
3. Squamous cell carcinoma, without prickle cells and without cornification.
4. Undifferentiated squamous cell carcinoma.

The following table gives the number of patients in each group

Table 2.

	Total	1.	2.	3.	4.
Free part of tongue	84	55	18	5	6
Base of tongue	61	35	15	7	4
Floor of mouth	55	34	11	7	3
Ca. buccae	69	53	8	4	4
Ca. gingivae	66	48	12	1	5
Ca. palati	51	31	12	3	5

The borderline between these groups is naturally not very marked, but as will be seen from the table, the greater number of patients, namely 332 (86 per cent) come into the groups of highly differentiated squamous cell carcinomas with cornification while only 54 (14 per cent) come into the groups of the slightly or completely undifferentiated squamous cell carcinomas without cornification.

Re-examining these cases we have not included the tumours of the salivary glands as these, clinically as well as histologically form a special group with different therapeutical problems to the squamous cell carcinomas.

Treatment

The treatment of carcinomas of the oral cavity is, in short, as follows: We start by treating the *primary lesion* with teleradium from 1—2 or more fields according to the size of the tumor and its situation. Our teleradium apparatus is of the latest model Sieverts, contains 3.0 grammes of radium and gives a skin dose per hour of 225 to 460 r depending on the size of the area treated and focus distance. The usual daily dose measured on the skin is 530 r which may be obtained by irradiation for $1^1/_2$ hours. We endeavour to get a uniform irradiation of the tumor and the surrounding tissue up to a tumor dose of 4500—5000 r attaining a favourable reaction on the mucous membrane. The primary lesion is re-examined after a period of 6—8 weeks. If any part of the tumor remains, it is coagulated or intubated with radium needles or both. The radium needles used contain 10 milligrammes of radium and are filtered with 1 mm Pt. These are placed $^3/_4$ to 1 centimetre apart and are left for 24 hours. In certain types of tumors other forms of surgical treatment may be employed after the Lesion of the mucous membrane has been treated radiologically; for instance resection of the maxilla when bone destruction has been proved in gingival cancer.

The treatment of *the regional lymph node areas* commences at the same time as the treatment of the primary tumor by including the adjacent lymph channels in the area of irradiation and thus giving it full »tumor-dose». Otherwise no prophylactic irradiation is given in Stage 1 and as previously mentioned, no prophylactic neck dissection is performed. Nor in cases where the lymph nodes are suspected cancerous (Stage 2) is neck dissection performed right away. In these cases the teleradium areas are arranged so as to include the suspected lymph nodes in the irradiation of the primary tumor or else the lymph node tumor is irradiated separately. The same is done when lymph nodes are clinically diagnosed as cancerous. If the lymph node tumor has entirely disappeared after 8 weeks, the patient is kept under observation. If on the other hand, a rest of the tumor remains, total neck dissection is performed if there are no contraindications to surgery and the primary tumor is free of symptoms or is considered cureable by further treatment.

In Stage 3 the indications are subject to greater individualisation particularly when more or less fixation of the lymph node metastases exists and the operability is doubtful. In these cases also treatment is started with irradiation. Teleradium is used if the tumor is limited and roentgen irradiation of cervical areas if metastases are extensive. When the 8 weeks observation period is terminated one is often faced with difficulty in deciding whether a lymph node metastasis, which is not quite movable, ought to be operated upon or not. There is no doubt that a patient can be completely cured even if the lymph node tumor is not quite movable, but the process may, on the other hand, be found to be more extensive than expected. If this is so, the frequency of recidivation and rate of mortality is high. This will be remarked on later.

With increased experience the tendency is to decrease rather than increase indications for neck dissection in these cases. This applies also to the indications for bilateral total neck dissection. In bilateral metastases which, from a technical point of view are probably operable, the least affected side is, if possible, operated upon first and vena jugularis interna left intact on this side.

Contralateral operable lymph node metastases do not occur in our material. We have tried a few times to operate metastases from slightly differentiated carcinomas, but with small success. In lymph node metastases with complete fixation only palliative roentgen irradiation is given.

Results

The results obtained in the treatment of intra oral carcinomas during the 10 years' period will be seen from Table 3. It is composed according to HAYES E. MARTIN's proposal for a tabular method for reports of final

Table 3.

Total number of cases. Per cent 3 yrs and 5 yrs cure.

Primary lesion	Ca. linguae Anterior $^2/_3$		Ca. linguae Posterior $^1/_3$		Cancer sublingual.		Cancer buccae		Cancer gingivae		Cancer palati		Total	
Observation period	3 yrs	5 yrs	3 yrs	5 yrs	3 yrs	5 yrs	3 yrs	5 yrs	3 yrs	5 yrs	3 yrs	5 yrs	3 yrs	5 yrs
Total number of cases	84	67	61	45	55	43	69	56	66	48	51	39	386	298
Dead as result of other causes and without re- currence Indeterminate group	3	6	4	5	2	4	4	5	1	1	7	7	21	28
Total ÷ Indeterminate Determinate group	81	61	57	40	53	39	65	51	65	47	44	32	365	270
Dead as result of cancer Failures	54	45	42	30	40	31	45	36	57	41	33	24	271	207
Free from disease 3 yrs, 5 yrs or more Successful results	27	16	15	10	13	8	20	15	8	6	11	8	94	63
Successful results/Determinate group	27/81	16/61	15/37	10/40	13/53	8/39	20/65	15/51	8/65	6/47	11/44	8/32		
3 yrs and 5 yrs or more results	33.3 %	26.7 %	26.3 %	25 %	24.5 %	20.5 %	30.8 %	29.4 %	12.3 %	12.7 %	25 %	25 %	25.8 %	23.4 %

results and includes all patients admitted to hospital with intra oral carcinomas with positive biopsy. Patients also are included who were considered intractable and therefore received a more or less incomplete treatment or no treatment at all. 298 patients were observed during a period of 5 years or more and the 5 years' results are calculated for this group. The 3 years' results of the entire material are also recorded and the discussion of treatment of lymph node areas is based on this material. We consider it right to do this as it gives us larger figures to work on and also because metastases from intra oral carcinomas, as distinct from lip carcinomas, are rare after 3 years.

As recorded in the table a 5 years' freedom from symptoms has been attained by 26 per cent of all cases of carcinomas localized in the free part of the tongue. The figures for other localizations are: base of tongue 25 per cent, reg. sublingualis 20 per cent, carcinoma buccae 29.4 per cent, ca. gingivae 12.7 per cent, ca. palati 25 per cent and for the total number of patients 23 per cent.

These figures are more or less equal the results attained in other radiotherapeutical clinics employing similar methods of treatment. BERVEN for instance gives the 5 years' results for intra oral carcinomas in the year 1945 as 25 per cent.

Looking at the results for the different stages, we find the chances of recovery diminishing rapidly in Stages 2 and 3. In order to save space, we shall not record these results in table form. In any case, the number of patients is too small to give percentages for the individual tumor groups. The 3 years' results for the total number of patients are: Stage 1 43.2 per cent, Stage 2 5.4 per cent and Stage 3 1.2 per cent.

From these figures it should not be concluded, as is often done in the literature on the subject, that the treatment of lymph node metastases is the most important problem in intra oral carcinomas, even more important than the treatment of the primary tumor. The figures rather illustrate the uselessness of a classification which makes no allowance for the size of the primary tumor. As the classification into stages must be based chiefly in the clinical diagnosis of the lymph node metastases, the value of the indicated results of treatment in each stage will be quite illusionary. The classification into stages is however necessary for the discussion of treatment of the lymph node areas. The main problem in the treatment of intra oral carcinomas is the treatment of the primary tumor. This will be clearly seen from Table 4 which gives an account of the causes of death of the 292 patients who died during the period of observation.

As will be seen from the table, of a total number of 292 patients 21 died symptom free from intercurrent disease, 8 died from distant metastases without local recidivation and, in the remaining 263, death was

Table 4.

The table shows the causes of death for the various localizations of the primary tumor in the 3 stages. The figures referred to in this discussion are in special type.

	Causes of Death.	Lingua Ant. $^2/_3$	Lingua Post. $^1/_3$	Sublingual cancer	Bucca	Gingiva	Palatum	Total	
Stage I	1. Primary lesion (No lymph node metast; or small operable)	11	11	9	14	20	14	79	*91*
	2. Primary lesion+inoperable lymph nodes	4	1	1	0	1	5	12	
	3. Lymph nodes metast. (Prim. lesion without recurrence	10	4	1	1	2	2	*20*	
	4. Distant metast. (Prim. lesion and lymph. node without recurrence	2	1	1	1	1	0	6	
	5. Dead as result of other causes without recurrence	1	3	2	4	1	7	18	
Stage II	1	12	6	4	6	19	4	51	*65*
	2	4	2	2	3	1	2	14	
	3 As above	0	2	0	3	0	0	*5*	
	4	0	0	1	0	0	1	2	
	5	2	0	0	0	0	0	2	
Stage III	1	0	0	1	0	0	0	1	*78*
	2	10	13	20	17	13	4	77	
	3 As above	1	2	0	0	0	1	4	
	4	0	0	0	0	0	0	0	
	5	0	1	0	0	0	0	1	

caused by the primary tumor, regional lymph node metastases or both. The large number of 234 out of these 263 had an incurable primary tumor and this alone was the cause of death in 131 cases; in 103 cases it was a contributory cause. The cause of death in each individual case, whether the primary tumor or the lymph node metastases, we do not discuss here.

The actual treatment of the primary tumor and the possibilities of improving on the results are outside this subject. We emphasize the fact, however, that in the great majority of cases the primary tumor is incurable with our present methods of treatment. Amongst our patients with intra oral carcinomas the primary tumor was a contributory cause of death in 234 out of 263 patients who died from cancer.

Treatment of Regional Lymph Nodes in Stage 1

Table 4 shows that only 29 patients died from regional lymph node metastases with the primary tumor symptom free of probably curable.

Table 5.

The table shows number of patients admitted without lymph node metastases who later developed these, operable or inoperable respectively.

	Cases admitted without nodes	Later on operable nodes	Later on inoperable nodes
Ca. linguae. anterior $^2/_3$	55	6	14
Ca. linguae posterior $^1/_3$	35	2	6
Ca. sublingualis	24	3	2
Ca. buccae	38	1	1
Ca. gingivae	33	3	2
Ca. palati	39	3	5
Total	224	18	30

These cases will be discussed later on. Twenty of them come into Stage 1, as may be seen from the table, and the question is whether they might have been saved if prophylatic dissection of the lymph nodes had been performed. Even if this had been so, it must be said that it would hardly have justified 224 lymph node dissections, which in this case would have had to be done prophylactically on all patients in Stage 1. In that circumstance 204 unnecessary operations would have been performed.

Before discussing this any further, we shall try to account for another aspect of the question by examining how many patients admitted without lymph node metastases developed these, operable or inoperable, later on. In reality it is only the patients who were admitted in Stage 1 and developed inoperable lymph node metastases during the course of the disease, who might have benefited by a prophylactic neck dissection. How this affected our patients will be seen from the following table 5.

It is evident from this table that only 30 of 224 patients, less that 13 per cent, developed inoperable lymph node metastases and therefore might have been saved by prophylactic neck dissection. As will be seen later on, this number will be reduced if the indications and contraindications are analyzed in the individual cases. The numbers of each group of tumors are small but the group carcinoma of the tongue with 114 patients of which 19.2 per cent later developed inoperable lymph node metastases, appears to be different to the group ca. buccae, gingivae and palati with 110 patients of whom 7.3 per cent later developed inoperable metastases.

The question is now whether prophylactic neck dissection could have been performed on all of these 30 patients. In 10 of them the primary tumor was not controlled and for this reason neck dissection was not indicated. There are left *20 patients*, the same twenty arrived at when

making up the table for the causes of death. But it is not certain that even all of these patients could have been saved by prophylactic neck dissection. In 7 cases lymph node metastases developed before the treatment of the primary tumor was ended. In one case neck dissection was done while metastases were operable, but the tumor was of the slightly differentiated cell type and recidivation occurred in the operative area. This patient ought not to have been operated upon. In two cases the first metastases occurred just above the clavicula and was therefore inoperable from the start. Whether these cases could have been saved by prophylactic neck dissection is not possible to say but it appears doubtful. Finally, in three cases neck dissection could not be performed because of the patients' great age, 77—88 years, and debilitas senilis.

Of the seven patients who might have benefited from a prophylactic neck dissection three were not control examined regularly, partly because they were feeling quite well and therefore did not report for examination and partly because they dreaded the long journey to the hospital. When, however, as in a country like Norway, long rough journeys influence a patient's availability for control examination, this is sooner an argument in favour of prophylactic neck dissection.

Therefore there were seven or, if the two who developed metastases above the clavicula are included, nine patients who might have benefited from a prophylactic neck dissection. But to prove this, prophylactic neck dissection on 224 patients would have been necessary and this could hardly be justified.

Of these nine cases none showed any particularly suggestive symptoms. Five women, all more than 60 years of age, had a limited tumor of highly differentiated type localized in the lateral border of the tongue. Two men, about 70 years old, had a tumor localized in the base of the tongue; both tumors were of the highly differentiated type, one small and the other very large. Finally, a woman of 66 had an extensive gingival tumor and a man of 64 an extensive tumor of the soft palate, both of the highly differentiated squamous cell type.

Our conclusion from this is that prophylactic neck dissection is not indicated in intra oral carcinomas and the patients under discussion, who might have been saved by it, did not show any special characteristics which would have made a selection possible. This problem is however not fully examined and the number of patients who were admitted in Stage 1 and later developed inoperable lymph node metastases — 19.2 per cent of tongue carcinomas and only 7.3 per cent of the groups ca. buccae, gingivae and palati — demonstrate that carcinoma of the tongue in this connection calls for special attention.

Treatment of the Lymph Node Areas in Stage 2

When patients are admitted in Stage II one is confronted with he alternative to operate immediately the primary tumor has been trea ed or to apply radiation treatment to the lymph node metastases sim ul-taneously with the primary tumor and operate 8 weeks later if the lym ph node tumor has not disappeared. In the Norwegian Radium Hospital we have always used the latter method and we have continued to do so also after the use of aspiration biopsy has shown to be a useful aid in making a more accurate diagnosis in cases of cervical metastases. We have no proof that by using this method we have lost any chances that patients might have had by surgical treatment of the lymph node areas. On the contrary, a number of patients have been spared a surgical operation as it was determined during the observation period whether the primary tumor could be checked or not.

If we look at the table recording the causes of death we find that in Stage 2 there is only a comparatively small number, 5 out of 72, who died from lymph node metastases while the primary tumor was symptom free or probably curable. In 51 cases the primary tumor alone was the cause of death and in 14 cases it was a contributory cause. Neck dissection would therefore have had to be performed on 65 patients in order to obtain a possible advantage for 5 of them.

On closer examination it will be found that even these 5 patients could not possibly have lost any chances by the primary radiation treatment. Two of them were operated upon after an observation period of 8 weeks and both developed recidivation in the operative wound. It is highly improbable that these patients would have escaped recidivation even if they had been operated upon in the first instance. Two patients developed lymph node metastases on the opposite side of the neck without recidivation on the operated side. The fifth patient was more than 80 years old and in poor general health. The operation was therefore omitted in spite of the metastases being small and easily operable.

Results of Total Block Dissection of the Lymph Nodes

These patients are discussed elsewhere by BULL ENGELSTAD and are mentioned here only where the results are of interest to the present discussion. The results are compiled in Table 6.

The clinical diagnosis of lymph node metastases can for our patients be judged only for the operated group. In Table 6 is included merely cases with positive biopsy, altogether 31 patients. Bilateral neck dissection was performed on 5 of them making in all 36 neck dissections with positive biopsy. In the examined group of patients a total of 33

Table 6.

The table shows number of total neck dissections, altogether 31.

	Clinically operable lymph node metastases. Stage II.	Clinically lymph node metastases, Stage III.
Postoperative death within 4 weeks	0	4
Died symptom free, from intercurrent disease within 3 years	1	2
Symptom-free 3—12 years	3	1
Dead from cancer *without* recidivation of lymph node metastases	8	2
Dead from cancer *with* recidivation of lymph node metastases on the operated side	3	7
Total	15	16

operations were performed. The clinical diagnosis had thus failed in 7 out of 43 cases (16.3 per cent). In a more extensive investigation BULL ENGELSTAD confirmed the diagnosis in 79.7 per cent of the cases.

How often an incorrect diagnosis is made in the opposite direction the number of times a cancerous lymph node is diagnosed as unspecific, cannot be estimated from the records of our patients.

The postoperative mortality was found by BULL ENGELSTAD in a more extensive material from The Norwegian Radium Hospital to be 1.8 per cent. It is of interest to notice in this connection that there was no postoperative mortality amongst the patients operated in Stage 2 as may be seen from Table 6. On the other hand, after operations performed on patients with more or less fixed lymph node metastases, 4 out of 14 died. These 4 were far advanced cases which should never have been operated upon. Three of them were found to have diffuse tumor infiltration in depth around the carotid bifurcation. All of them were diagnosed in advance as of doubtful operability. The fourth patient was 75 years old and senil dement. The operation was apparently radical but it increased debility and the patient died from bronchopneumonia 8 days later. The immediate cause of death in the other three patients was also bronchopneumonia.

The risk of recidivation is, as may be expected, least in Stage 2 since only 3 of 15 patients developed recidivation on the operated side. In Stage III seven of the 12 surviving patients developed recurrence on the operated side. Taking the two stages together we find that of 27 patients surviving the operational trauma, 10 developed lymph node metastases on the operated side.

Bilateral neck dissections with positive biopsy have been performed 5 times. One patient died 6 days after the last operation. Two died symptom free from intercurrent disease 5 and 10 months respectively after the last operation. One developed local recidivation on the side of the neck where vena jugularis interna was preserved and one died from the primary tumor 4 months later without recidivation in the regional lymph node areas.

None of these patients obtained any lasting benefit from these two major operations and even if three out of five of them did not develop local recidivation, we cannot maintain that bilateral neck dissection will ever be successful, as the observation period was too short.

Histologically the tumors in 27 of the 31 operated cases belonged to the group of highly differentiated squamous cell carcinomas while only 4 were of the less differentiated type. The operations on these 4 cases were unsuccessful as two patients died within 4 months from the primary tumor without recidivation in the operative area, one patient died within 10 months from metastases in the lungs without local recidivation and one patient died within 9 months from recidivation in the operative area.

The conclusion, even if those figures are few, is that they confirm our opinion that total neck dissection has a low mortality when performed on patients with clinically operable metastases. The operation is a highly radical treatment and the chances of recidivation are small even if metastases have been histologically proved. In patients with more or less fixed metastases however, surgical treatment has high mortality and there is no guarantee that local recidivation may not develop. The operation is very rarely, if ever, successful in bilateral cervical metastases, and in metastases from slightly differentiated types of carcinomas.

Discussion and Summing up

It is apparent that the results of treatments of intra oral carcinomas in our clinic are about the same as those obtained in other therapeutical clinics employing similar methods. In spite of improved methods during the last 15—20 years, it is still the prognosis of the primary tumor which decides the fate of the patient. Only a small number of patients have died from cervical metastases while the primary tumor was symptom free or curable. The possibilities of improving the results of the treatment of the primary tumor are outside this discussion.

In Stage 1 prophylactic neck dissection is not indicated. One reason for this is that it would have necessitated 224 operations on our patients to obtain possible advantages for seven or at most nine patients. 176 of

these patients never developed cervical metastases at all. Total neck dissection is moreover, when performed on assured operable cervical metastases, an operation with low mortality and little chance of recidivation. This means that the patient as far as cervical metastases are concerned, has a good chance of remaining symptom free after the operation even if operable metastases should develop later on.

In Stage 2 it appears from our figures that it is justified to give radiation treatment to the cervical metastases first and operate after an observation period of about 8 weeks. This increases the possibilities for estimating the curability of the primary tumor and a number of patients may be saved an unnecessary operation without reducing their chances by radical neck dissection later on.

In Stage 3 with fixed or bilateral cervical metastases, neck dissection is as a rule not indicated. Judging the degree of fixation in this case is a matter for certain individualization and our clinic, which has practically never used interstitial radium treatment for cervical lymph node metastases, is in this instance inclined to extend the indications for neck dissection to include patients with metastases showing commencing fixation. As already mentioned, a wider use of interstitial radium treatment may possibly limit the indications for neck dissection for this group of patients.

In the histologically undifferentiated types of tumors the results from surgical treatment are unsatisfactory whereas those from radiation treatment are good. On this account surgical treatment is, as a rule, hardly ever indicated.

Great age, poor general health and other unfavourable symptoms are also contraindications to neck dissection.

As a result of the present re-examination we have not reached any conclusion which justifies changing the already mentioned indications for the treatment of regional lymph node areas in intra oral carcinomas, but we have established a sounder basis for our indications in cases where we previously were guided by clinical judgement only. Our indications are altogether similar to those quoted from J. J. DUFFY's works. It must be emphasized that even in our country where the patients have to undertake long and strenous journeys in order to attend regular control examinations, we find no reason to extend the indications for prophylactic neck dissection. It happens, however, more often in cases of tongue carcinomas than in cases of cheek-, gum- and palate carcinomas that the patients die from lymph node metastases with symptom free or curable primary tumor, and even if we have not yet found any guidance for chosing the patients with tongue carcinomas who might be eligible for prophylactic neck dissection we do not intend to leave the problem unsolved but will closely observe our patients with this in mind.

SUMMARY

The indications for neck dissections in intra oral carcinomas are discussed on the basis of the re-examination of the Norwegian Radium Hospital's material from 1932 to 1941, 386 cases, all verified by histological examination. Three and five years results, the causes of death, the development of lymph node metastases, and the results of neck dissections have been examined. In *Stage I* prophylactic neck dissection is not indicated. In *Stage II* radiation treatment of the cervical metastases is started simultaneously with the treatment of the primary tumor, and neck dissection is performed 8 weeks later if the lymph node tumor has not disappeared. Neck dissections in operable metastases from highly differentiated carcinomas have a low mortality and little chance of recidivation. Patients with metastases from lesser differentiated carcinomas, however, ought not to be operated upon. In *Stage III* there is every reason to limit the treatment to palliative irradiation.

ZUSAMMENFASSUNG

Die Indikationen der Halsdrüsenausräumung bei intraoralen Krebsen werden an Hand einer Nachuntersuchung des Materials des Norwegischen Radiumkrankenhauses aus den Jahren 1932—1941 besprochen, 386 Fälle, alle durch histologische Untersuchung bestätigt. Die Ergebnisse nach drei und fünf Jahren, die Todesursachen, die Entwicklung von Lymphdrüsenmetastasen und die Ergebnisse der Halsdrüsenausräumung sind untersucht worden. Im *I. Stadium* ist die prophylaktische Halsdrüsenausräumung nicht angezeigt. Im *II. Stadium* wird Strahlenbehandlung der Halsmetastasen gleichzeitig mit der Behandlung des Primärtumors eingeleitet, und wenn der Lymphdrüsentumor nach 8 Wochen nicht verschwunden ist, so wird die Halsdrüsenausräumung vorgenommen. Nach Halsdrüsenausräumung bei operablen Metastasen von hoch differenziierten Krebsen ist die Mortalität niedrig und die Wahrscheinlichkeit eines Rückfalls gering. Kranke mit Metastasen von weniger differenziierten Krebsen hingegen sollten nicht operiert werden. Im *III. Stadium* hat man allen Grund, die Behandlung auf palliative Bestrahlungen zu beschränken.

RÉSUMÉ

L'auteur discute les indications de l'évidement cervical dans les carcinomes intrabuccaux en se basant sur les examens ultérieurs de contrôle du matériel de l'Hôpital Norvégien du Radium des années 1932 à 1941. Il s'agit de 386 cas, tous vérifiés histologiquement. On a étudié les résultats après trois et cinq ans, les causes de la mort, le développement des métastases dans les ganglions lymphatiques, et les résultats des évidements cervicaux. Au *stade I* l'evidement prophylactique n'est pas indiqué. Au *stade II* l'irradiation des métastases cervicales est mise en train en même temps que celle de la tumeur primitive, et l'évidement cervical s'exécute 8 semaines plus tard si la tumeur ganglionnaire n'a pas disparu. Les évidements dans les métastases opérables de cancers hautement différenciés sont grevés d'une faible mortalité et de peu de risques de récidive. En revanche, les malades avec des métastases de cancers moins différenciés ne devraient pas être opérés. Au *stade III* il y a toutes les raisons de réduire le traitement à une irradiation palliative.

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AUS DEM RÖNTGENINSTITUT DER UNIVERSITÄT BERN
(DIREKTOR: PROF. DR A. LIECHTI, †)

DIE DARSTELLUNG DER BEWEGUNG DES MITRALRINGES MIT PHASENGEZIELTEN HERZAUFNAHMEN[1]

von

O. Hubacher, Bern

Die wenigen in der Literatur niedergelegten Studien über die Bewegung des Mitralringes wurden anhand von röntgenkinematographischen Aufnahmen ausgeführt. Die Röntgenkinematographie hat bei diesen Untersuchungen ohne Zweifel grosse Vorteile, sie lässt sich aber, wie dies alle Forscher und namentlich ODQVIST betonen, wegen der grossen technischen Schwierigkeiten nur in Ausnahmefällen — bei extremtransparenten Patienten und äusserst dichten Verkalkungen — erfolgreich durchführen. Von dieser Tatsache konnten auch wir uns überzeugen; es gelang uns z. B. beim unten ausführlich beschriebenen Falle einer 71-jährigen adipösen Frau nicht, brauchbare Filmaufnahmen herzustellen, trotzdem wir uns an dieselben Bedingungen hielten wie BENNER, KJELLBERG, SJÖSTRAND und HOLM, die über grosse Erfahrung in der Röntgenkinematographie verfügen. Wir benützten eine 16 mm Schmalfilmkamera mit einem Spezialobjektiv Oeffnung 1 : 0.95! und einen hochempfindlichen Film bei einer Röhrenbelastung von 95 KV/100 mA/3 Sek. Umso wichtiger scheint uns, beim derzeitigen Stand der Röntgenkinematographie eine neue Methode zu beschreiben, die zur Feststellung und Beurteilung von Bewegungsvorgängen von entscheidendem Werte ist und im Gegensatz zur Röntgenkinematographie bei allen, sogar adipösen Patienten (wie z. B. der im folgenden beschriebene Fall) Verwendung finden kann.

Unser verehrter, kürzlich verstorbener Chef Prof. AD. LIECHTI hat eine Apparatur konstruiert, mit der es möglich ist, die Röntgenapparatur in verschiedenen Zeitpunkten des Elektrokardiogrammes zu schalten. Es handelt sich um einen Elektrokardiographen, der, nachdem er auf

[1] Bei der Red. am 28. Jan. 1947 eingegangen.

ne bestimmte EKG-Phase eingestellt worden ist, selbsttätig die Röntgenaufnahme auslöst. Die Apparatur spielt bei der Grössenbeurteilung des Herzens und der Thoraxstereometrie eine Rolle und ist neuerdings von mir zur Ausarbeitung einer neuen röntgenologischen Methode zur Schlagvolumenbestimmung benützt worden. Die Belichtungszeit der selbsttätig ausgelösten Aufnahmen ist standartisiert. Sie beträgt immer 0.04 Sek., sodass es möglich ist, während einer Herzrevolution bei einer Normalfrequenz von 70/Min mehrere Aufnahmen herzustellen. Im allgemeinen genügen 3—5 Bilder, damit der Bewegungsvorgang ausreichend zerlegt werden kann. Eine solche Bewegungsanalyse soll im Folgenden bei einem instruktiven Fall einer grossen Verkalkung des Annulus fibrosus der Mitralis durchgeführt werden.

S. E. ♀, *71-jährig*, Puls regelmässig, Blutdruck 170/95 mm Hg, zugewiesen von der Lory abt. des Inselspitals.

Klinischer Herzbefund: Spitzenstoss 2 QF ausserhalb der Medioklavikularlinie, absolute Dämpfung vergrössert, laute systolische Geräusche über der Aorta, Mitralis, Tricuspidalis und Pulmonalis, die wahrscheinlich als Sklerosegeräusche zu deuten sind.

Elektrokardiogramm: Sinusrhythmus, Frequenz 86/Min., PQ 0.14″ P 0.11″ (verlängert), QT 0.42″ (verlängert). Grösste Ausschläge in Abl. 1 nach oben, in Abl. 3 nach unten, T_1 negativ. Beurteilung: QT-Verlängerung, Hypertrophiealveogramm.

Röntgen: Vergrössertes, aortisch konfiguriertes Herz mit einer mächtigen nach oben und rechts offenen bogenförmigen, schnellend pulsierenden Verkalkung der Mitralis. Die Verkalkung kann wegen der Adipositas der Pat. einerseits und der grossen Herzfüllung andererseits nur bei maximaler Ausblendung erkannt werden. Differentialdiagnostisch kann eine umschriebene Perikardverkalkung ausgeschlossen werden, da die gefundene Veränderung nicht randständig gedreht werden kann. Meist soll die Perikardverkalkung auch im Sulcus coronarius an der Herzunterfläche beginnen (KLASON, DETERMANN). Eine Myokardverkalkung zeigt regelmässige, dem Muskelfaserverlauf entsprechende Streifung (GEIPEL). Die Koronarsklerose manifestiert sich durch parallele, bogenförmige Schattenlinien entsprechend dem Verlauf der A. coronaria (LENK). Der verkalkte Herzthrombus gibt einen randständigen, homogenen Schatten, die keinesfalls die starke Pulsation der Herzklappe oder des Mitralringes aufweist. Ueberhaupt ist das wichtigste Kriterium der Verkalkung der Mitralklappe oder des Annulus fibrosus die auffällig stark *tanzende Bewegung* des Schattens. Deshalb soll diese Bewegung im folgenden näher analysiert werden.

Es wurden innert einer Herzrevolution 5 Röntgenaufnahmen in bestimmten EKG-Abschnitten (s. Abb. 1) hergestellt (Bedingungen: 90 KV, 400 mA, 0.04 Sek., Raster, Kodakfilm, Abstand 70 cm, sehr starke Ausblendung). Bei Aufeinanderprojektion der 5 Einzelbilder ergab sich erwartungsgemäss die Abb. 2. Die Annulus fibrosus-Verkalkung ist auf dieser Summationsdarstellung an *5 deutlich verschiedenen Stellen* nachzuweisen. Wenn wir von der Aufnahme 1 (auf der P-Zacke) ausgehen, so sehen wir, dass die Verkalkung in der Reihenfolge der Aufnahmen nach unten gegen die Herzspitze wandert bis zur Aufnahme 3, die am Ende der T-Zacke, also am Systolenende gelegen ist; dann erfolgt

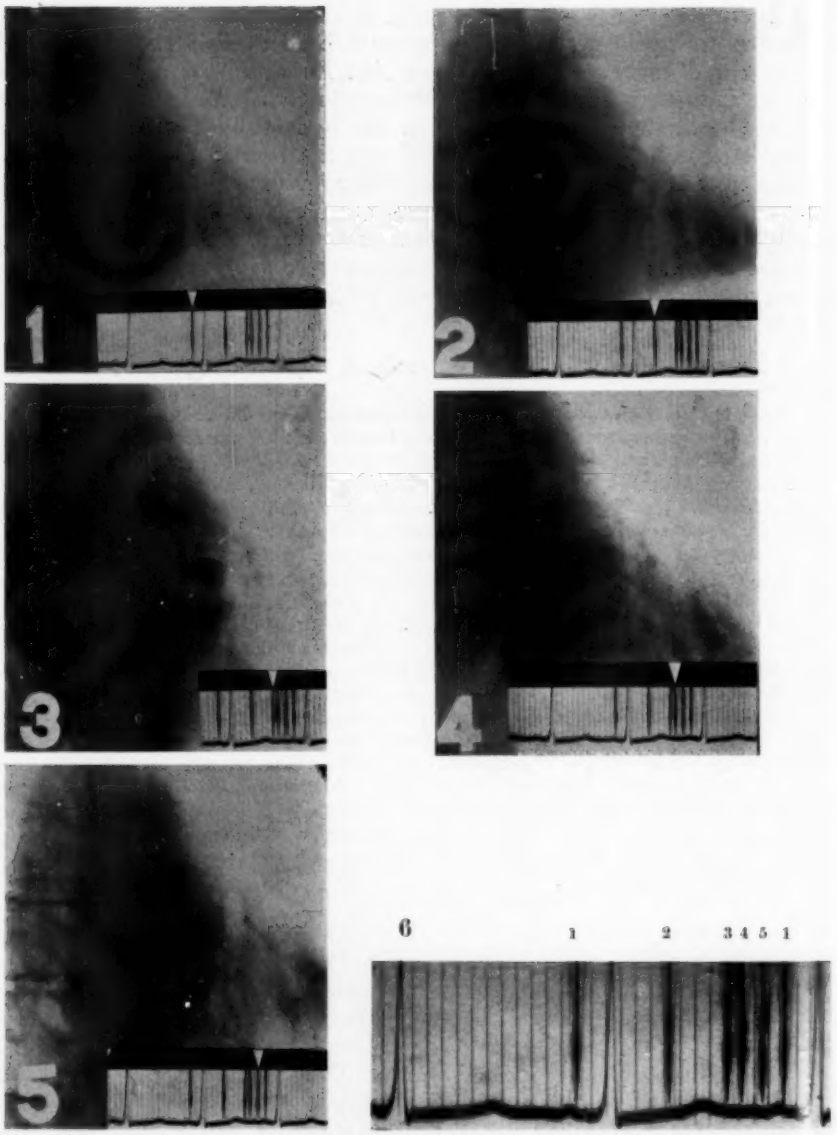

Abb. 1—6. Fall S. E. ♀ mit einer grossen nach oben und rechts offenen Verkalkung des Annulus fibrosus der Mitralis, dargestellt in 5 phasengezielten ausgeblendeten Aufnahmen während *einer* Herzrevolution. Darunter Elektrokardiogramm desselben Falles in Abl. 2 mit Bezeichnung des genauen Ortes der phasengesteuerten Aufnahmen. Die Zahlen im Elektrokardiogramm korrespondieren mit denjenigen der Röntgenbilder.

Abb. 7. Summationsdarstellung (Filmpause) der Annulus-fibrosus-Verkalkung desselben Falles. Die Verkalkung ist in 5 deutlich verschiedenen Stellen nachzuweisen. Sie bewegt sich während der Systole nach der Herzspitze, während der Diastole gegen die Herzbasis. Die folgenden Ziffern bezeichnen den Aufnahmezeitpunkt im EKG und korrespondieren mit den Ziffern der Abb. 1.

———— = Lage der Verkalkung im Zeitpunkt 1
– – – – – – – – – – – – = » » » » » 2
... —— ... —— = » » » » » 3
..... = » » » » » 4
. — . — . — = » » » » » 5

eine Aufwärtsbewegung bis die Ausgangsstellung wieder erreicht ist. Unsere Untersuchungen stimmen mit denjenigen von BENGT S. HOLMGREN überein, indem auch wir eine *geradlinige* Hin- ind Herbewegung der Annulus fibrosus-Verkalkung nachweisen konnten. Sie bestätigen die Bemerkung HOLMGRENS, dass bei genau sagittalem Strahlengange nie eine Dreiecksform der Mitralverkalkungsbewegung, wie sie ODQVIST beschreibt, zustandekommt.

ZUSAMMENFASSUNG

Der Vorteil der Darstellung der Bewegung des Mitralringes mit phasengezielten Herzaufnahmen liegt darin, dass sie im Gegensatz zur kinematographischen Darstellung bei allen Patienten und nicht nur in Ausnahmefällen (extreme Transparenz, sehr dichte Verkalkung) möglich ist. Da die Herzröntgenaufnahme durch das EKG selbsttätig ausgelöst wird und der Auslösezeitpunkt automatisch auf dem EKG registriert wird, kann die genaue Lage des verkalkten Mitralringes und damit des Septum atrioventriculare zu jeder beliebigen Zeit der Herzrevolution ermittelt werden. Vielleicht können dadurch Anhaltspunkte für das Schlagvolumen gewonnen werden.

SUMMARY

The author points out the advantage to represent the movements of the mitral ri g by simultaneous registering to the contraction phases. In opposition to cinematograph ', his technique allows examination of all patients and is not only available in exceptio l cases (such as extreme transparancy, dense calcareous deposits). As the screen picture f the heart is automatically released by the Ecg., exact position of the calcareous mit l ring, therefore the Septum atrioventriculare, may be explored on the very moment f cardiac revolution one should be interested in. This technique may be suitable for further attempts at closer studies concerning the volume of cardiac output.

RÉSUMÉ

L'avantage de la mise en évidence des mouvements de l'anneau mitral par des radiographies du cœur coordonnées avec les phases de son travail consiste en ceci que, contrairement à l'enregistrement cinématographique, elle est possible chez tous les malades et pas seulement dans des cas exceptionnels (transparence extrême aux Rayons; calcification très opaque). Comme la radiographie du cœur est commandée par l'E. C. G. lui-même, et que sur celui-ci l'instant du déclenchement est enregistré automatiquement, on peut repérer à tout moment que ce soit de la révolution cardiaque la situation exacte de l'anneau mitral calcifié, et ainsi celle du septum atrio-ventriculaire. Peut-être peut-on par là obtenir des indications volumétriques.

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FROM RADIUMHEMMET (CHIEF: PROF. E. BERVEN) AND THE RADIOPHYSICAL INSTITUTE (CHIEF: PROF. R. SIEVERT)

THE INFLUENCE OF RADIOACTIVE PHOSPHORUS ON TUMOUR GROWTH IN MOUSE TUMOUR C. 2146 AND BROWN-PEARCE RABBIT CARCINOMA[1]

by

A. Forssberg and *F. Jacobsson*

In a previous work (1) we discussed the distribution of radioactive phosphorus (P^{32})[2] in rabbits grafted with Brown-Pearce carcinoma as well as in intact ones. It was stated that during the first days after the administration of P^{32} growing metastases accumulate more radioactive phosphorus than most normal tissues although not more than do liver, spleen and kidney, but also, that after a couple of days this favourable difference was more or less eliminated. This is in accordance with the findings of other authors. It is doubtful whether an attempt to stop the development of growing tumours or metastases would be successful with P^{32} therapy when they have reached an appreciable magnitude, particularly as the marrow, surrounded by the bones which accumulate P^{32} to a very high degree, must be exposed to considerable irradiation. It is probable that the dosage limit is set by the tolerance of the bone-marrow. LAWRENCE (2) has expressed the same opinion.

It would seem worth while, however, to consider the possibility, that the early stages in the tumour development *e. g.* the very onset of the primary tumour or the metastases may be especially radiosensible. In that case even moderate dosages may have some beneficial effect. Some experiments to that end have been carried out. Owing to the limited supply of radioactive phosphorus the Brown-Pearce rabbits proved to be unsuitable. The greater part of the work was done on the Mouse Tumour Strain C. 2146 from the Laboratories of the Imperial Cancer Research Fund.

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[2] We are much indebted to Prof. M. SIEGBAHN, Institute for Experimental Physics of the Royal Academy, for his kindness in supplying radioactive phosphorus.

Experiments with C. 2146:

This tumour was originally induced by painting the skin of a mouse with coal tar in 1926.[1] When first propagated it was a typical skin cancer but after propagation over a number of years is has altered its histological character and now it is difficult to say whether it is a sarcoma or not. It is said to take in up to 100 % by transplantation (CRAMER and CRABTREE, 3) and it grows very rapidly invading adjacent tissues; metastases are rare due to the rapid rate of growth, *i. e.* the host is killed before metastases develop. Spontaneous regression is said to occur comparatively seldom (GYE, 4). The tumour was started in transplantation by W. E. GYE at the Laboratories of the Imperial Cancer Research Fund. According to CRAMER's experience, the tumour is usually about $5 \times 7 \times 4$ mm after 8 days. The tumour is radiosensible and full regress can be achieved by radium (CRAMER, 5).

In our experiments the tumour also showed a high percentage of positive »takes» to the graft. Of our material comprising 351 animals, 334 were positive. Common white laboratory mice, with an average weight of 20 gr, were grafted subcutaneously on the dorsal side. In some series male animals were grafted, in others females; no difference could be found in the reaction of the two sexes. The animals were fed an ordinary bread and milk diet. The growth was fast, showing an average increase of the tumour volume from a pin's head to about the size of a hazelnut in ten days. Unfortunately, it proved in the course of the experiments that a fairly high percentage of the animals not treated with P^{32} showed a spontaneous regression of the tumour in some series in spite of the fact that the tumour at first grew out rapidly and to an appreciable size. This occurred for instance in five of the seven cases recorded in Table I under Group 3, Column III, and renders the figures in the other two groups somewhat unreliable with respect to the quantitative extent of the irradiation effect. In our opinion, however, the following tables and curves will nevertheless prove that the tumour growth was substantially affected by the radioactivity.

As we were studying the P^{32} effect on the early stages of the tumour development we found the following scheme convenient for the first experiments: In each group we injected 26 mice as follows:

1. 60 μC/animal, fractionated in doses of 10 μC and given intraperitoneally on 6 consecutive days with the first injection 24 hours before the graft.
2. As in 1., but the first injection given at the graft.
3. Grafted, but untreated animals.

[1] We thank Dr W. E. GYE for a personal communication concerning the history of the tumour.

In view of the high dosage given here it seemed almost certain that deleterious irradiation effects, and possibly death, would frequently occur. Then TUTTLE, ERF and LAWRENCE (6) had found that for mice, weighing 20 gr, 70 μC radiophosphorus is lethal in one to two weeks. A quite high dosage was, however, considered necessary in order to have a clear cut answer to the question whether it would be at all possible to affect the tumour growth. Thus we chose the dosage 60 μC/mouse, or about 2.5 μC/gr.

Table 1.

26 mice per group; results classified as follows:

I.	II.	III.	IV. Alive after 6 weeks		V. Dead in the course of the experiment		
						Probably from irradiation insult	
Group	P^{32}-dosage	Tumour has almost disappeared, or was never developed ( )	With regressed tumour	With well developed tumour	With actively growing tumour	During the early growth of the tumour	With the tumour in regress
1.	60 μC/6 days. First dose 24 hours before graft.	17 (1)	14	—	4	3	5
2.	60 μC/6 days. First dose at the graft.	4 (0)	4	7	12	1	2
3.	Controls, grafted but untreated	7 (2)	7	4	15	—	—

We have recorded the results after 6 weeks, when the differences have become fairly pronounced, and tabulated the material (Table I) from different points of view. In Column V we have tried to estimate the principal cause of death. Animals dying before the tumour had reached any appreciable size or after the tumour had regressed were tabulated as irradiation injuries; for those dying during the stage of maximum tumour development the main cause of death was assumed to be the cancer. Of course, it is not possible to draw a distinct limit between the two classes. It is *e. g.* probable that the diminished vitality caused by the tumour has contributed to the figures for irradiation injuries. Nevertheless the fact that all the 15 dead controls succumbed in a state of highly developed tumour growth but none during the early development or in the condition of regression supports the conclusion that the dosage of radiophosphorus was fatal in some cases.

Considering the effect of the radiophosphorus on the tumour development we may first note the difference between Group I on the one side and Groups II and III on the other. Whereas no significant effect of the treatment can be detected in Group II 6 weeks after the injection,

the figures in Group I point to a retarding action on the tumour grow th. It appears as if the comparatively small quantity of 10 μC, injected 24 hours before the graft, has been almost entirely responsible for the effect and, consequently, we assume that the possibility to affect the tumour growth under these experimental conditions is limited to the first hours of the tumour onset. The influence seems in other words to be principally exerted by the radiophosphorus anchored in the tissue at the time of the graft. The results are so far not encouraging from a therapeutic point of view, especially when we consider the primary tumour which is not likely to be accessible for very early treatment. There remains, however, the possibility that small amounts of radiophosphorus, anchored in the body, may to some extent prevent the development of metastases.

As metastases in C. 2146 are uncommon we must confine ourselves to a study of the P^{32}-action on the development of the grafted tumour. Next we repeated the experiments in Table 1, Group 1. but with descending quantities of radiophosphorus. The radioactive phosphorus was consequently given on 6 consecutive days with the first injection 24 hours before the graft (Table 2). The progress of the tumour growth revealed a distinct effect on the animals treated with 60 μC as in the previous series. After a normal onset and development of the tumour up to approximately 10 days after the graft, the growth stopped fairly suddenly and the tumours regressed and disappeared rapidly.

Table 2.

8 mice in each series. Results after 6 weeks.

P^{32} in μC.	Tumour totally regressed	Death probably caused by:		Alive
		Irradiation injury	Tumour	
60	7	3	1	4
12	1	—	7	1
3	0	—	8	0
0	0	—	8	0

The fact that the three animals died after the disappearance of the tumour indicates that this dosage is just about as much as can be survived. Possibly deaths from this cause may occur later although experience has shown that such cases are rare. Dosages as small as 12 μC per mouse are probably quite ineffective.

Some experiments bearing upon a purely »prophylactic» action of the radioactive phosphorus were then made. During the three days preceeding the inoculation the animals were treated with P^{32}; we distributed quantities from 10 to 40 μC in the hope to find a suitable dosage which

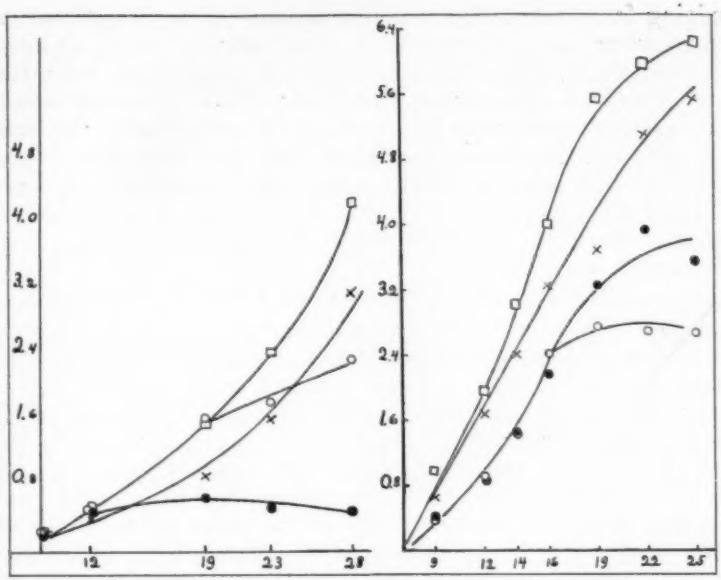

Fig. 1. Fig. 2.

Fig. 1. x = controls; □ = 10 μC; ● = 20 μC; ○ = 40 μC.
Tumour size in cm³ at different times in days after the inoculation.

Fig. 2. x = controls; □ = 15 μC; ● = 20 μC; ○ = 25 μC.
Tumour size in cm³ at different times in days after the inoculation.

would check the tumour growth without being lethal (Fig. 1). The number of animals in this and the following series varied between 8—13 in each trial. The tumour volumes were calculated from measurements of the three dimensions of the tumours. The measuring could not be continued for more than 3—4 weeks owing to the necrotic decomposition of the tumours and the increased death rates.

The retardation of the tumour growth is evident with the dosage 20 μC, but less so with 40 μC. To explain the latter fact we believe that in this case a complex action of the radioactivity is probable, *e. g.* a destructive action both on the normal functions of the organism and on the neoplasm. The net result may be an effect opposite to the desired one if the former action prevails. The complexity of the problem to find the suitable dosage for a tumour, growing with a certain speed and administer it at the proper time is also clearly indicated when compared with the following experiment (Fig. 2).

Judging from Fig. 1 the optimum action on the tumour growth appeared to occur after approximately 20 μC so we injected quantities of that magnitude in the second series (Fig. 2). The tumour now showed a more rapid and stronger growth compared with the previous series. Possibly this is the reason why the effect of the radioactivity was this time less pronounced. The results suggest that stronger doses had been necessary here in order to obtain a more pronounced influence upon the tumour growth. Then there is an obvious difference in reaction between the two series and this is probably due to the different rates of growth of the tumour.

The curves in both the series indicate, that the stoppage of the growth through the influence of the radioactivity may occur quite suddenly and at rather an advanced stage. In both series too we observe slightly increased tumour growth in animals which have been given a small quantity (10—15 μC) of radioactivity. Provided this result is reliable (the series have hitherto not been very extensive) it would mean that we must search for a probably very narrow concentration range of the radioactivity in order to exert the optimum influence on the tumour growth, and this concentration range seems moreover to be dependent on the growth rate of the tumour.

One serious drawback is the quite high death rate among the animals treated with P^{32}. The assumption that the radioactive phosphorus also in these last two series caused deaths could be made almost with certainty from the fact that out of in all 57 P^{32} treated mice, 12 succumbed at a stage where the tumour had almost disappeared or at least was highly in regress. Among the animals not treated with radiophosphorus and in which the tumours spontaneously regressed (we registered 14 such cases in the course of the whole investigation) we never had deaths after the disappearence of the tumour. Judging from the experience with the tumour C. 2146 and the isotope P^{32} there would seem to be little chance of finding a concentration range of radioactivity that while effective as a therapeutic agent gives no severe irradiation injuries.

Owing to an occasional lack of radioactivity we were not in a position to proceed further with our investigations into this question. We hope, however, to be able later on to investigate more closely the relation between the rate of tumour growth and the effects of the irradiation.

An estimate of the P^{32}-concentration in the tumour and the rest of the body was made at a stage of vivid tumour growth. Six animals which had been given totally 60 μC during Nov. 5th—10th were sacrificed on Nov. 23rd with well developed and growing tumours. Analyses were made of the radioactivity in the tumour and the rest of the body:

Tumour		Rest of the carcass	
Weight, gr.	P^{32} μC/gr.	Weight, gr.	P^{32} μC/gr.
3.06	1.4×10^{-1}	23.3	3.2×10^{-1}
1.56	1.2	21.2	4.3
5.42	1.6	20.0	5.5
3.57	1.1	19.6	3.5
2.33	1.1	20.6	5.6
1.57	1.0	21.5	6.0
M = 2.92	1.2×10^{-1}	21.0	4.7×10^{-1}

The mean quantity left in whole body was 10 μC per animal. The figures show that the radioactivity remaining in the normal parts of the body was four times that remaining in the tumour. From many earlier investigations we know that the bones hold by far the largest amount of the radiophosphorus remaining a few weeks after the administration of P^{32}. This circumstance probably explains the uneven distribution.

Experiments with Brown-Pearce Carcinoma.

Only a few experiments were carried out owing to the great amount of P^{32} required to obtain conclusive results. The results so far obtained are given in Table 3. In a first attempt ~ 1.5 mC were given intravenously to three animals on the dates shown in the table. The results were negative. All the treated animals died as did the untreated ones, and the dissection showed the same development of the metastases.

In the following experiments the dosage per animal was increased to ~ 3 mC. The dissection several months after the graft showed that three animals out of four were completely free of symptoms, whereas the corresponding figure for the untreated animals was one out of four. Of course, the limited material does not allow any conclusions to be drawn. The figure for »cured» animals is, however, quite high considering that from a material comprising 92 animals KALLÓS (7) found only 17.5 % non-infected ones and we ourselves 27 % out of 26 rabbits grafted. The white blood-cell count was checked weekly after the injection of the radiophosphorus. No abnormal alterations were found in the treated animals. Dr. L. SANTESSON of the Pathological Institute of Radiumhemmet was so kind as to examine sections of the treated tumours. However, no alterations likely to be due to the irradiation were found.

The authors wish to express their gratitude for a grant from P. A. Ljungberg's Fund.

Table 3.

Rabbit No.	Grafted.	P^{32} injected.	Dosage in mC.	Dead (+) or surviving (—).	Frequency of metastases in various organs.[1]	Frequency of the all over frequency.
1.	$^{29}/_{11}$	—	—	+ $^{5}/_{1}$	Li +++ Lu +++ Ly ++ Om and Me +++ Dia +++ Ur +++	++
2.	»	$^{2-5}/_{12}$ 0.67 $^{11-14}/_{12}$ 0.80		+ $^{27}/_{12}$	Li +++ Ki +++ Lu +++ Om and Me + Dia + Ur +	++
3.	»	—	—	+ $^{15}/_{12}$	Death on an early stage with but a few metastases developed.	+
4.	»	$^{2-5}/_{12}$ 0.67 $^{11-14}/_{12}$ 0.80		+ $^{9}/_{2}$	Ki +++ Om +++ Me +	++
5.	»	»	»	+ $^{20}/_{1}$	Li ++ Ki + Ly ++ Om + Me ++ Dia ++ Ur +++ Pe +++	++
6.	»	—	—	+ $^{20}/_{1}$	Ly + Om + Pe +	+
7.	$^{9}/_{2}$	$^{16-17}/_{3}$ 1.5 $^{21-24}/_{3}$ 1.3 $^{22-25}/_{3}$ 0.5		—	Sacrificed and dissected $^{24}/_{7}$; quite normal.	0
8.	»	»	»	—	Sacrificed and dissected $^{24}/_{7}$; quite normal.	0
9.	»	—	—	+ $^{9}/_{4}$	Li ++ Ki +++ Lu ++ Om and Me +++	+++
10.	»	—	—	+ $^{13}/_{6}$	Ki +++ Ly + Ur ++ Pe +	+
11.	$^{19}/_{4}$	$^{19-21}/_{4}$ 1.5 $^{27-29}/_{4}$ 1.5		—	Sacrificed and dissected $^{24}/_{7}$; quite normal.	0
12.	»	»	»	+ $^{29}/_{5}$	Frequent occurrence in all organs, except in the liver	+++
13.	»	—	—	[2] + $^{12}/_{7}$	No metastases.	0
14.	»	—	—	—	Ki + Ly + Ur ++ Sacrificed and dissected $^{24}/_{7}$.	+

Frequency of metastases: 0 = no metastases. + = scanty. ++ = frequent. +++ = very frequent.

[1] Liver (Li), Kidney (Ki), Lungs (Lu), Lympatic organs (Ly), Omentum (Om), Mesenterium (Me), Diaphragm (Dia), Urinary tract (Ur), Peritoneum (Pe).

[2] From an infection.

SUMMARY

P^{32} was administered intraperitoneally to mice, grafted with the Tumour C. 2146 and the tumour growth was followed. Even as high dosages as 60 μC had little influence when given during 6 days with the first dose at the graft. When the first dose was given 24 hours before the graft disappearance of the tumour was frequently found. The quantitative relation between tumour growth and dosage was studied after a prophylactic treatment with P^{32}. In certain concentrations P^{32} then inhibits the growth. Deaths occurred, however, among the animals and it seems to be difficult to find a concentration range in which P^{32} is effective as a therapeutic agent but with no deleterious effects on the body.

ZUSAMMENFASSUNG

Mit dem Tumor C. 2146 geimpfte Mäuse bekamen P^{32} intraperitoneal, und darauf wu le das Tumorwachstum verfolgt. Selbst die hohe Dosis von 60 μC hatte geringe Wi kung, wenn sie 6 Tage lang, und zwar die erste Dosis gleichzeitig mit der Imfpung, geg ben wurde. Wurde die erste Einspritzung 24 Stunden vor der Impfung gegeben so bek m man in grossem Ausmasse einen Rückgang des Tumorwachstums. Die quantitat en Beziehungen zwischen Tumorwachstum und Dosis wurden nach einer prophylaktisc en Behandlung mit P^{32} studiert. In gewissen Konzentrationen hemmt P^{32} das Wa hstum. Tötliche Strahlenverletzugen kamen jedoch vor, und es scheint schwer ein Kon zentrationsgebiet zu finden, wo P^{32} als therapeutisches Mittel wirksam ist, aber kein schädlichen Wirkungen auf den Organismus ausübt.

RÉSUMÉ

Le P^{32} fut administré par voie intrapéritonéale à des souris à qui l'on avait fait des greffes de la Tumeur C. 2146, et la croissance du néoplasme fut observée. Des doses atteignant même jusqu'à 60 μC n'exercèrent guère d'influence lorsqu'elles étaient données pendant 6 jours en débutant le jour même de la greffe. Quand la première dose était appliquée 24 heures avant la greffe on constata fréquemment une disparition de la tumeur. Le rapport quantitatif entre la croissance de la tumeur et la dosimétrie fut étudié après un traitement prophylactique par le P^{32}. A de certaines concentrations le P^{32} inhibe la croissance. Il y eut, cependant, des morts parmi les animaux, et il semble difficile de trouver une marge de concentration dans laquelle le P^{32} soit un agent thérapeutique efficace sans avoir d'effets délétères sur le corps.

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FROM THE STATE HOSPITAL, REYKJAVIK, ROENTGEN DEPARTMENT
(CHIEF: G. CLAESSEN, M. D.)

MASS RADIOGRAPHY OF THE CHEST[1]

A Report

by

Gisli Fr. Petersen

During recent years rather extensive fluoroscopic studies have been made in Iceland on the initiative of the Tuberculosis Control, mainly in the form of mass examinations of certain population groups considered to be particularly exposed to tuberculous infection. Fluoroscopic studies with transportable roentgen ray units have been made in several parts of the country. — As in many other countries, fluoroscopy has also mostly replaced roentgenography in mass examinations here, for economical as well as technical reasons. Paper film has partly substituted the roentgen film in group survey work. It is inexpensive, but its bulk makes it difficult to handle during the examination when speed is essential. The files also require too much space. In addition, more care is needed in exposing and developing these films than roentgen film.

In some ways the fluoroscopic method is suitable for the study of population groups. A low power roentgen apparatus, also transportable, may be used, and no film processing equipment is required. Actually, however, certain difficulties are connected with this method. With the technique used at the present time the fluorescent image is by no means as clear as one might desire. The radiologist must concentrate all the time; he therefore tires easily and his vision becomes less exact. Besides, he runs the risk of excessive radiation exposure. Still, the fluoroscopic method may undergo great improvements, amplifying the fluorescent image many times (electronic tubes — LANGMUIR, FARNSWORTH).

Photofluorography has marked an epoch in mass radiography of the chest. Immediately before the war miniature films, especially 35 mm., were in rather extensive use in Europe. At the same time POTTER was performing investigations in the U.S.A. which led to the introduction of the so-called photo-roentgen unit with films 4 × 5 inches (about 10 × 13 cm). The Roentgen Department of the State Hospital in Reykjavik was equipped with such a unit in 1942—43.

[1] Submitted for publication Febr. 8, 1947.

As a link in the campaign against tuberculosis the Icelandic Public Health Service conducted a case finding program including all the inhabitants of Reykjavik during the first half of 1945. The examinations were carried out by the Health Centre, Tuberculosis Department, under the supervision of the Medical Director for Tuberculosis Control. The photofluorograms were made at the Roentgen Department of the State Hospital. — As yet, such case finding programs with photofluorograms including the inhabitants of a whole city have been rather rare. Therefore, the writer finds it warrantable to report our experience, particularly in view of the fact that such programs are being prepared elsewhere. Studies of population groups and of soldiers have been made in several places. During the years 1941—44, for instance, 20,000,000 photofluorograms were made in the U. S. A.[1]

The equipment used in our Department for photofluorography is a modern installation (from General Electric X-ray Corp.) with rotating anode tube capable of handling 400—450 ma of current at from 55 to 70 kv., an impulse timer. Tube-screen distance 1 m. Exposure time $^1/_{20}$—$^4/_{20}$ sec. according to the thickness (antero-posterior diameter) of each individual patient, measured with calipers. The fluorescent screen is a specially prepared, extremely sensitive fluorazure screen. The lens is with a rating of F. 1.5. Time-temperature development. 2 kv. variation for each 1 cm. variation in the thickness. If the thickness was about 30 cm. or more, the technique was 200 ma, 80 kv, $^2/_{10}$—$^3/_{10}$ sec. If the thickness was about or in excess of 35 cm., the films were practically useless. According to expectations it proved more difficult to obtain well exposed films of muscular men than of obese persons.

The rotating anode tube is easily applicable for about 15,000 exposures. From then on more current was required in order to obtain well exposed films. After 17,000—18,000 exposures it had to be discarded. The focus had then become very rough, not unlike a rough lava-field *en miniature*.

The films were viewed through an illuminator designed for the purpose, fitted with a fluorescent daylight Mazda lamp. The films must be well illuminated and it is an easy matter to diagnose 300 films in 2 hours. A classification was made into 3 groups: (a) normal, (b) pathological, and (c) defective films. The films were viewed without magnification, but an ordinary reading glass has proved helpful. Apart from tuberculous changes, these films often reveal useful information about other lesions in the lungs or heart.

Compared with radiograms of normal size of the same patient, the photofluorograms were found to yield extremely reliable details.

The practical arrangement of the survey program was as follows: Nurses from the Health Centre went from house to house in order to call

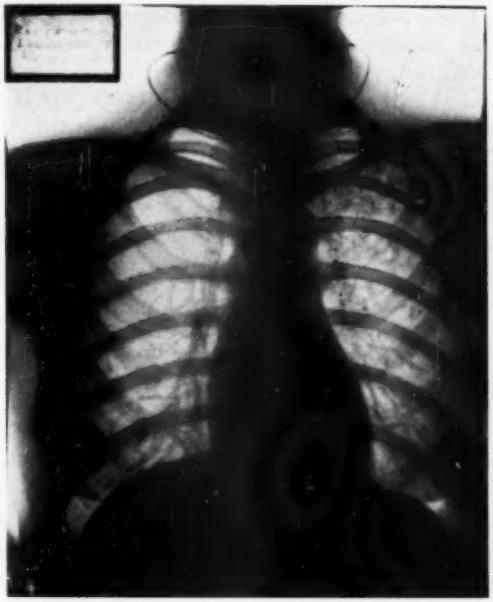
[1] HILLEBOE—MORGAN: Mass Radiography of the Chest, 1945.

in the subjects for the roentgen examination and perform tuberculin tests on the children, covering certain streets and quarters at a time. Males and females above 13 years of age were asked to appear at a stated time for photofluorography, and children between 7 and 13, showing a positive tuberculin reaction, were submitted to the same examination. Positive children between 1 and 7 were fluoroscoped at the Health Centre. Babies younger than 1 year of age were not submitted to any special examination, unless there was occasion to do so. It was ascertained that they were not suffering from tuberculosis. Certain groups, *e. g.* schools, were taken separately. Experience revealed that the equipment available allowed a speed of 70 photofluorograms per hour. At a higher speed mistakes, like two exposures on the same film, are more apt to occur. The films are carried in simple 4 × 5 in. double holders. A pause of 10 minutes each hour was made, as a precautionary measure in order to cool the tube. The roentgen examination was made after usual working hours, *i. e.* in the afternoons and evenings. The subjects could then choose the hour which suited them best. The examination was carried on for 5 hours each day, with a pause of 1 hour, which no doubt makes the tube last longer. It then has an opportunity for cooling, although it should not become overheated by an uninterrupted examination of this duration.

As each subject presented himself for examination, his name, date and year of birth, as well as address were written down on a special identification card to be inserted into a built-in film-marker. This case identification is exposed on the film. Each subject is given his identification card to present when it is his turn. The staff required was a minimum of 2—3 to receive the subjects and write out the identification cards, 2—3 nurses to expose the films, and 1—2 in the dark-room. In programs like these it is important to avoid making people wait, as it is apt to cause discontent and reluctance to turn up at the examinations.

The program took 4 months, during which time a total of 43,595 persons were examined by tuberculin test, by photofluorography, and at the Health Centre, by fluoroscopy. Of those expected to be able to attend 98.15 per cent. came for the examination. Only a few subjects were examined later when it was possible to get in touch with them.

522 or 1.17 per cent. were partly examined. It was a question of invalids, old and infirm persons who could only be moved with difficulty. These examinations were made in old age homes or mental hospitals. In suspected cases, the sputum was examined and the physician of the person in question consulted. In case a child showed a positive tuberculin reaction, every person in the household was roentgen examined without exception. It was impossible to get hold of 220 persons, mainly sailors, and 82 were not to be found at the address given on the



♀ aged 19. — Photo-roentgenogram taken at mass examination. Original size 4 × 5 inches. The patient had not consulted a doctor earlier — Tub infiltrate at the top of left lung + tubercle bacilli in the sputum.

census list. Thus, it was impossible to get in touch with 0.68 per cent. who therefore were not examined. — It is evident that the attendance surpassed the most optimistic expectations.

About 31,600 photofluorograms were made. Larger films and special films were made in cases that proved doubtful or suspicious on the miniature films. On comparison, the miniature films were also found to afford a clear picture of the pathological changes in the lungs.

A total of 1,329 were called in for re-examination at the Health Centre, either because the films were positive or suspicious, or else technically deficient or practically useless; *e. g.* those taken of patients with an antero-posterior diameter of about 35 cm. or more. New films were then made in numerous cases.

Seventy-one or 0.16 per cent. of the subjects were found to suffer from active pulmonary tuberculosis. 56.3 per cent. of this number were positive (sputum and stomach-lavage). The Health Centre had not previously been aware of these cases.

The majority or 60.3 per cent. of the fresh cases were in the age group 15–30. It is, however, a striking and important observation that a good deal of tuberculous cases were found among those older than 60, who constituted 8.4 per cent. of the cases found.

All the figures mentioned above are derived from the report given by Dr. Sigurdur Sigurdsson, Medical Director for Tuberculosis Control in Iceland.

It will be seen from this survey that the public were extremely willing to appear for the examination. This must for a great part be due to the fact that nothing was left undone to arouse their interest in the program and make them perceive its importance. Lacking public interest, such programs would be difficult to carry out. Before as well as during the program, the press and wireless had interviews with and lectures by the Medical Director for Tuberculosis Control. Another matter of great importance is to allow the public to choose their own time, as far as it is compatible with the program. The examination should also be conducted at an effective speed allowing a maximum of 20 minutes from the time the subject arrives until he can leave. The subjects were divided into groups called in at half-hourly intervals.

Conclusions

Photofluorography employing 4 × 5 in. films is a practical and economical method, especially in the study of large population groups. Films of this size are suitable for this work, as they may be viewed without magnification. They are also useful in the follow-up examinations of the lungs of patients who must remain under control.Compared with full-size films of the same patient, the miniature films proved quite clear and reliable.

SUMMARY

Report of an examination of the inhabitants of Reykjavik, Iceland. About 31,600 photofluorograms with films 4 × 5 inches were made. 71 (0.16 %) of the subjects were found to suffer from active pulmonary tuberculosis. The majority or 60.3 % of the fresh cases were in the age-group 15—30 and 8.4 % were among those older than 60.

ZUSAMMENFASSUNG

Bericht über eine Untersuchung an den Einwohnern von Reykjavik, Island. Es wurden etwa 31,600 Schirmbildaufnahmen mit Film von ungef. 10 × 12 cm gemacht. Es stellte sich heraus, dass 71 (0.16 %) der Untersuchten an aktiver Lungentuberkulose litten. Die Mehrzahl oder 60.3 % gehörten zu der Altersgruppe von 15—30 Jahren, und 8.4 % waren über 60 Jahre alt.

RÉSUMÉ

Rapport sur un examen auquel furent soumis les habitants de Reykjavik, Islande. On fit environ 31,600 radiophotographies sur des films d'environ 10 × 12 cm. 71 sujets (0.16 %) furent trouvés atteints de tuberculose pulmonaire en activité. La majorité, soit 60.3 %, des cas récents ressortissaient à la classe d'âge de 15 à 30 ans, et 8.4 % étaient représentés par des vieux de plus de 60 ans.

DIE RÖNTGENDIAGNOSE DER »PSEUDOABSZESSE« DER LUNGE[1]

von

Robert Lenk, Tel-Aviv

Es unterliegt heute kaum mehr einem Zweifel, dass die anatomischen Substrate der früher unter dem Sammelbegriff »Pseudokavernen« zusammengefassten, röntgenologisch durch einen innerhalb heller oder verdichteter Lungenfelder gelegenen Ringschatten charakterisierten Gebilde mitunter alte, bindegewebig abgekapselte Zerfallshöhlen, dünnwandige bronchiektatische Kavernen, abgesackte interlobäre Pneumothoraxräume, angeborene Cysten oder die zurückgebliebene Kapsel ausgehusteter Echinokokken sind, dass ihnen aber in weitaus den meisten Fällen Emphysemblasen zu Grunde liegen. Experimentell wurden sie schon im Jahre 1927 von LAURELL erzeugt (s. unten); von klinischem Gesichtspunkt hat sie als einer der ersten KLEINSCHMIDT im Jahre 1930 beschrieben. Es handelt sich dabei allerdings selten um die vesikuläre Form eines substantiellen Emphysems (darüber s. später); es ist auch sehr unwahrscheinlich, dass ein vikariierendes Emphysem sich röntgenologisch als Ringschatten oder kreisrunde Aufhellung präsentiert, wie z. B. noch ULRICH im Jahre 1936 angenommen hat. Die Ursache dieser blasigen Gebilde ist vielmehr nach der jetzt vorherrschenden Ansicht eine Ventilstenose kleiner oder grösserer Bronchien, meist verursacht durch Schleimhautschwellung oder Schleimpropfen; durch Zerreissung der Wände aufgeblasener Alveolen entstehen diese blasigen Gebilde. Dass man sie durch Überdruck erzeugen kann, hat LAURELL durch Einblasen von Luft in die Trachea herausgenommener Kalbslungen erwiesen. Sie sind seither wiederholt in der menschlichen Pathologie unter verschiedenen Bezeichnungen, wie »blebs und bullae«, »regional obstructive emphysema«, »pulmonary pneumatocele« beschrieben worden. Man beobachtet sie, wie auch unsere Erfahrung lehrt, fast ausschliesslich bei Kindern; die Ursache dafür liegt in der Enge des kindlichen Bronchialbaums und vielleicht auch in der relativen Armut der kindlichen Lunge an elastischem Gewebe.

[1] Bei der Red. am 20. I. 1947 eingegangen.

Von besonderer Bedeutung sind diese Emphysemblasen dann — und das ist das häufigste Vorkommen —, wenn sie im Verlaufe fieberhafter, klinisch als genuine oder häufiger lobuläre Pneumonie imponierender Erkrankungen auftreten, weil man sie dann leicht mit Lungenabszessen verwechselt, besonders wenn sie gross sind und Flüssigkeit (Bronchialsekret) enthalten, was nicht selten vorkommt; darauf hat vor allem CAFFEY aufmerksam gemacht. Der gutartige Verlauf von Lungenabszessen bei Kindern war ja schon lange aufgefallen; offenkundig hat es sich meistens um Verwechslung mit derartigen Emphysemblasen gehandelt. Es ist deshalb vielleicht angebracht, in diesem Zusammenhang von »*Pseudoabszessen*» zu sprechen. Auf ihr Vorkommen bei lobulären Pneumonien haben zuerst wohl PEIRCE und DIRKSE im Jahre 1937 und bald darauf BENJAMIN und CHILDE (1939) aufmerksam gemacht. Besonders eingehend aber hat sie CAFFEY an Hand eines grösseren Materials im Jahre 1940 beschrieben. Seither ist wiederholt über Emphysemblasen im Verlaufe oder nach Ablauf von kindlichen Pneumonien berichtet worden.

Wir haben hier eine Reihe solcher Bilder bei Fällen, die klinisch meist unter dem Bilde von Bronchopneumonien oder fieberhaften Bronchitiden verliefen, beobachtet und ich habe über sie bei einer Tagung der Palästinensischen Röntgengesellschaft im Jahre 1941 und gemeinsam mit E. NASSAU, der sie vom klinischen Gesichtspunkt behandelt hat, in einer Sitzung der kinderärztlichen Gesellschaft in Tel-Aviv im Jahre 1943 berichtet. Es ist jedoch nicht meine Absicht, die Kasuistik dieser Erkrankung zu bereichern, sondern ich möchte mich mit der bisher kaum behandelten Möglichkeit der praktisch so wichtigen frühzeitigen röntgenologischen Differentialdiagnose zwischen echten und Pseudoabszessen der Lunge beschäftigen.

Zunächst seien aber kurz einige charakteristische Fälle beschrieben. Sie entstammen der Kinderabteilung des Spitals in Ofulah. Für die Überlassung der Krankengeschichten danke ich Hm. Dr. NASSAU auch an dieser Stelle.

Fall 1. B. Z., 2 J. alter Knabe. Im Juli 1939 zum ersten Male wegen einer Bronchopneumonie im rechten Oberlappen aufgenommen. Lytische Entfieberung; nach 14 Tagen gesund entlassen. Am 4. VIII. 1939 wegen Rezidiv der Pneumonie an gleicher Stelle wieder eingeliefert. Röntgenologisch intensive inhomogene Verdichtung des rechten Oberfeldes (*Bild 1*). 6 Tage später im Röntgenbild (*Bild 2*) weitgehende Aufhellung; cca. haselnusskerngrosser, längsovaler, innen scharf, aussen unscharf begrenzter, verschieden breiter Ringschatten. Die Annahme eines Abszesses erschien wegen der nur subfebrilen Temperatur und des guten Allgemeinbefindens unwahrscheinlich. Weitere 6 Tage später bei wieder zunehmender Temperatur etwas intensivere Verdichtung. Der Ringschatten nicht mehr zu sehen. (*Bild 3*). Nach einer weiteren Woche nur noch mässige inhomogene Verschleierung des rechten Oberfeldes mit lappenmässiger Begrenzung. Auch jetzt der Ringschatten nicht zu sehen. (*Bild 4.*) Nach 1 Monat geheilt entlassen. Kurze Zeit darauf rasch vorübergehendes Rezidiv der Pneumonie; die ringförmige Aufhellung blieb jedoch verschwunden.

Bild 1.

Bild 5.

Bild 2.

Bild 3.

Bild 4.

Bild 1. Fall 1. Lipoidpneumonie des rechten Oberlappens.

Bild 2: Fall 1. 6 Tage später. Verdichtung aufgehellt. Haselnussgrosser Ringschatten mit den Qualitäten eines »Pseudoabszesses».

Bild 3. Fall 1. Weitere 6 Tage später. Das Infiltrat wieder etwas dichter. Der Ringschatten geschwunden.

Bild 4. Fall 1. Eine weitere Woche später. Wieder Aufhellung des Infiltratschattens. Der Ringschatten bleibt verschwunden.

Bild 5. Fall 2. Infiltratschatten in der Lingula mit etwas unregelmässig begrenzter zentraler Aufhellung.

Bild 6.

Bild 7.

Bild 8.

Bild 9.

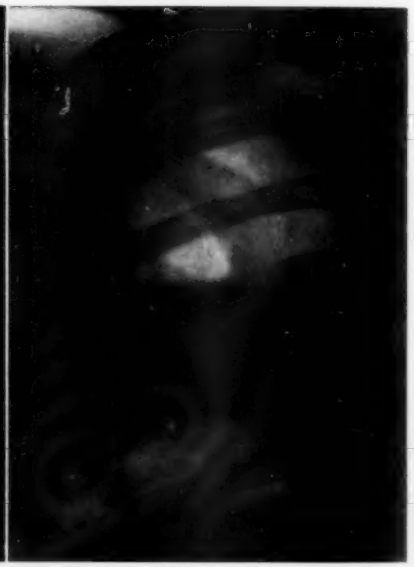


Bild 10.

Bild 6. Fall 2. 8 Tage später. Kirschengrosser Ringschatten an der Stelle des Infiltrates.

Bild 7. Fall 2. 3 Tage später. Der Ringschatten (»Pseudoabszess«) beträchtlich kleiner, daneben eine »plattenförmige Atelektase« (FLEISCHNER).

Bild 8. Fall 2. Weitere 3 Tage später. Der Ringschatten undeutlich geworden, der Streifen geschwunden.

Bild 9. Fall 3. 2 grosse Höhlen mit Flüssigkeitsniveaux im rechten Mittelfeld, Ringschatten in der Höhe der Clavicula.

Bild 10. Fall 3. 2 Tage später. Die beiden grossen Höhlen zusammengeflossen. Der Ringschatten in der Höhe der Clavicula deutlich kleiner geworden.

Wegen des wiederholten Erscheinens der pneumonischen Veränderungen an der gleichen Stelle wurde die Erkrankung als »Lipoidpneumonie» gedeutet, zumal anamnestisch langdauernder Gebrauch von paraffinhaltigen Nasentropfen und zwangsweise Fütterung von Lebertran nachzuweisen war. Mantoux bis 1 : 10 stets negativ.

Fall 2. R. M. $3^1/_2$ Jahre altes Mädchen. Am 27. V. 1940 mit Fieber erkrankt, 1 Tag später mit den Zeichen einer Bronchitis ins Spital aufgenommen. Röntgenuntersuchung am 5. VI. ergibt einen kleinen Infiltratschatten links im Bereiche der Lingula mit einer unregelmässig begrenzten zentralen Aufhellung. (*Bild 5.*) Dabei gutes Allgemeinbefinden und subfebrile Temperatur. Bei der nächsten Untersuchung am 13. VI. cca. kirschengrosser regelmässiger Ringschatten, stellenweise dünn, stellenweise etwas breiter, nach aussen unscharf begrenzt. (*Bild 6.*) 3 Tage später ist dieser Ring beträchtlich verkleinert, nur noch cca. kirschkerngross. Lateral davon ein schmaler bandförmiger Schatten, wahrscheinlich plattenförmige Atelektase (FLEISCHNER). (*Bild 7.*) Nach weiteren 3 Tagen ist der Ring undeutlich geworden, der Streifen geschwunden. (*Bild 8.*) Am 30. VI. vollkommen fieberfrei, am 4. VII. geheilt entlassen.

Der nächste Fall sei nur kurz als Beispiel für grosse, teilweise flüssigkeitshaltige Pseudoabszesse beschrieben, aus der grossen Reihe seiner Bilder nur einige wenige wiedergegeben:

Fall 3. W. O. 4 Jahre altes Mädchen. 6 Tage vor Aufnahme ins Spital allmählich ansteigendes Fieber. Bei der Aufnahme am 7. I. 1941 die klinischen Zeichen einer Pneumonie des rechten Unterlappens. Bei der ersten Röntgenuntersuchung am 15. I. eine zunächst als Abszess gedeutete kleinapfelgrosse, teilweise mit Flüssigkeit gefüllte Höhle mit nach innen scharfer, nach aussen unscharfer Begrenzung in der Gegend der rechten Unterlappenspitze. Dabei ist aber auffallender Weise die Temperatur beträchtlich abgefallen, das Allgemeinbefinden ist gut. Im Sputum niemals elastische Fasern. 2 Tage später sind 2 breite Flüssigkeitsniveaux im rechten Mittelfeld zu sehen, in der Höhe der Clavicula ist ein neuer cca. haselnussgrosser schräg-ovaler verschiedenbreiter, innen scharf, regelmässig, aussen unscharf begrenzter Ringschatten aufgetreten. (*Bild 9.*) Weitere 2 Tage später sind die beiden erstgenannten Höhlen in eine cca. apfelgrossen Hohlraum mit die ganze Breite des rechten Lungenfeldes einnehmendem Flüssigkeitsniveau zusammengeflossen, der Ring in der Höhe der Clavicula ist deutlich grösser geworden. (*Bild 10.*) 5 Tage später am 24. I. ist das Kind völlig fieberfrei geworden und bis zu seiner Entlassung am 13. II. geblieben. Die Röntgenkontrollen ergeben eine rasche Verkleinerung aller Höhlen, ausserdem Anhaltspunkte dafür, dass eine von ihnen durch einen interlobären Pneumothorax erzeugt war (*Bild 11*). Am 5. II., also 17 Tage nach Bild 10, nur noch ein ungefähr kirschengrosser zarter Schattenring im rechten Mittelfeld und völliges Verschwinden der Höhle in der Höhe der Clavicula (*Bild 12*). Während dieser ganzen Zeit völliges Wohlbefinden. Am 13. II., also 6 Wochen nach der Aufnahme mit normalem klinischem und Röntgenbefund geheilt entlassen.

Es muss wohl nicht näher ausgeführt werden, wie wichtig im Hinblick auf die Prognose und die eventuell einzuleitende Therapie eine frühzeitige Differentialdiagnose zwischen echtem und Pseudoabszess der Lunge ist. Man stützt sie fast allgemein mit CAFFEY auf das relativ gute Allgemeinbefinden der Patienten und den gutartigen Verlauf der Erkrankung, auf das manchmal sehr frühzeitige Auftreten, das oft rasche Verschwinden und die mitunter zu beobachtenden starken Grössenschwankungen der

Höhlen, also im wesentlichen auf den Ablauf der Krankheit. In seinem schönen Lehrbuche »Pediatric X-ray Diagnosis» sagt CAFFEY: »Es gibt keine befriedigende Röntgenmethode für die Unterscheidung von emphysematösen und Zerfallshöhlen.» Nur LEOPOLD und KRATZMANN sprechen in einer kürzlich erschienenen Publikation von einem charakteristischen Röntgenbild. Es handelt sich allerdings in den 2 von ihnen beschriebenen Fällen nicht um Frühdiagnosen, da die Höhlen erst nach Lösung von Pneumonien auftraten, resp. sichtbar wurden. Sie beschreiben die Aufhellungen als ovoid, gelegentlich auch rund und manchmal mehrkämmerig (»loculated»); die Begrenzung wird als dünner, dichter und glatter Rand beschrieben. Auch sie weisen auf die Grössenschwankungen hin.

Auch uns hat bei der Sicherung der Diagnose das gute Allgemeinbefinden und der gutartige Verlauf gute Dienste geleistet, wenn es nach unserer Erfahrung auch mitunter Fälle von echten Lungenabszessen mit ähnlich günstigem Verlaufe gibt. Von vertvollen klinischen Symptomen möchten wir noch das von uns immer beobachtete Fehlen des foetiden Geruches und von elastischen Fasern im Sputum hinzufügen. Von den röntgenologischen Symptomen halten wir ebenso wie CAFFEY u. a. das rasche Auftreten und das rasche Verschwinden, sowie eventuelle Grössenschwankungen der Höhlen für diagnostisch wichtig.

Darüber hinaus aber glaube ich, dass gewisse röntgenologische Beobachtungen und theoretische Erwägungen, die den Entstehungsmechanismus der Höhlen resp. die physikalischen Verhältnisse im befallenen Lungenabschnitt berücksichtigen, uns Symptome liefern, die die richtige Diagnose schon sehr frühzeitig auch auf Grund des Einzelbildes wenigstens mit grosser Wahrscheinlichkeit gestatten. Die Beobachtung ergibt, dass in allen diesen Fällen die Aufhellungen sofort bei oder wenige Tage nach ihrem Auftreten eine regelmässige, runde oder ovale, mitunter polycyclisch begrenzte Form haben. Im Gegensatz dazu ist die frische Zerfallshöhle unregelmässig konfiguriert. Die Begrenzung der Emphysemblasen wird durch einen Ringschatten gebildet, der nach innen, also gegen die Aufhellung scharf begrenzt ist und sich, wenn die Höhle innerhalb durch Infiltration oder häufiger wohl Atelektase verdichteter Lunge sitzt, gegen diese oft noch als dichterer, scharf gezeichneter Streifen absetzt, wenn er aber in sonst heller Lunge gelegen ist, eine ungleichmässige Breite und nach aussen, also gegen die gesunde Lunge eine unscharfe Begrenzung aufweist. Die frische Zerfallshöhle ist hingegen immer unscharf begrenzt; denn der regelmässige Schattenring entsteht beim Lungenabszess erst durch die bindegewebige Kapsel, also in einem relativ späten Stadium.

Wie lässt sich diese verschiedenartige Symptomatologie der beiden in Rede stehenden Erkrankungen erklären? Die theoretische Erwägung ergibt folgende physikalische Differenz zwischen einer frischen Abszesshöhle und einer durch Ventilstenose entstandenen Emphysemblase: Die

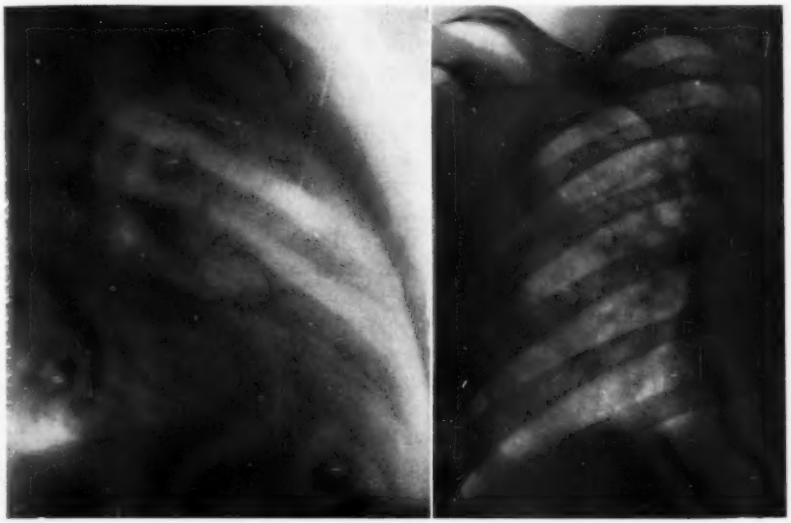


Bild 11. Bild 12.

Bild 11. Fall 3. 10 Tage später. Frontalaufnahme. Interlobärer Pneumothorax.
Bild 12. Fall 3. Eine weitere Woche später. Nur noch 1 kleiner dünner Ringschatten im rechten Mittelfeld.

Zerfallshöhle stellt einen unter dem normalen Atmosphärendruck stehenden Luftraum innerhalb einer ziemlich starren Masse, der massiv infiltrierten Lunge dar; die auf Grund einer Ventilstenose entstandene Emphysemblase steht unter Überdruck, häufig innerhalb mehr oder weniger atelektatischer, also wohl elastischerer Lunge; denn in diesen Fällen ist die Kombination von in- und exspiratorischer und Ventilstenose auf Grund desselben pathologisch-anatomischen Vorgangs häufig (s. dazu die Arbeit von SNOW und CASSASA). Der Überdruck erklärt die regelmässige Konfiguration des Luftraumes, deren Zustandekommen durch die Retraktion der atelektatischen Lunge noch begünstigt wird. Ob das Gebilde kugelige oder ovoide Gestalt hat, hängt davon ab, ob die Retraktionskraft der benachbarten gesunden Lunge in allen Richtungen die gleiche ist oder nicht. Die mitunter vorkommende polycyklische Konturierung ist wohl durch Konfluenz mehrerer Blasen zu erklären, analog der gekerbten Begrenzungslinie von Schatten bei der Konfluenz schattengebender Bildungen, also etwa von Drüsentumoren (s. dazu den allgemeinen Teil in meinem Buche über die Röntgendiagnostik intrathorakaler Tumoren, S. 19). Der Überdruck in dem Luftraum der in Rede stehenden Gebilde erklärt auch die Entstehung und die Qualitäten des beschrie-

benen Schattenringes, dessen anatomisches Substrat neben den Resten der dünnen Alveolarwände ein durch die Kompression bedingter Atelektasering ist. Diese Kompressionsatelektase ist von LAURELL in den oben zitierten Versuchen nachgewiesen worden; sie wird auch von CAFFEY als Substrat des Schattenringes angesehen. Die scharfe Abgrenzung dieses Ringes gegen den Luftraum hat seine Ursache darin, dass hier die atelektatische Zone von der aus den stehengebliebenen Resten der zerrissenen Alveolarwände bestehenden Membran überkleidet ist. Die Unschärfe der äusseren Grenze erklärt sich durch den allmählichen Übergang von atelektatischer zur normal lufthaltigen Lunge (s. auch hierzu die allgemeinen Ausführungen in meinem oben genannten Buche, S. 20). Die ausschlaggebende Bedeutung der atelektatischen Zone in der Umgebung der durch Ventilstenose entstandenen Emphysemblasen ergibt sich auch aus der allgemein bekannten Tatsache, dass auch sehr grosse Emphysemblasen eines substantiellen Emphysems im Röntgenbild sehr oft überhaupt nicht zu sehen sind; diese Lufträume stehen nicht unter Überdruck, es fehlt ihnen deshalb der durch Kompressionsatelektase entstandene Ring.

Es ergibt sich also aus diesen Ausführungen, dass eine im Verlaufe einer fieberhaften Erkrankung der Lunge entstandene, von allem Anfang an oder kurz nach ihrem Auftreten regelmässig geformte Aufhellung mit nach innen ganz scharfer, nach aussen gewöhnlich unscharfer Begrenzung mit grösster Wahrscheinlichkeit für die Diagnose einer durch Ventilstenose entstandenen Emphysemblase (»Pseudoabszess») verwertbar ist und so die frühzeitige Differenzierung gegenüber einem echten Abszess gestattet.

Hinzugefügt sei nur noch, dass ein früher symptomlos verlaufener Echinococcus nach teilweisem Aushusten seines Inhaltes zu dem gleichen Symptomenkomplex führen kann, natürlich nur dann, wenn es zu einer entzündlichen Infiltration in seiner Umgebung gekommen ist, weil ja bei Fehlen eines Atelektaseringes nur auf diese Weise die unscharfe äussere Konturierung des Schattenringes zustande kommen kann. In echinococcenreichen Ländern muss man, namentlich bei Erwachsenen, bei denen die beschriebenen Emphysemblasen nur ganz ausnahmsweise vorkommen, an diese Möglichkeit denken. Die richtige Diagnose ist durch den Sputumbefund und Hauttest leicht zu stellen.

ZUSAMMENFASSUNG

Es wird neuerlich auf das häufige Vorkommen von durch Ventilstenose entstandenen Emphysemblasen im Verlaufe von kindlichen Lungenerkrankungen hingewiesen und für sie die Bezeichnung »Pseudoabszesse» der Lunge vorgeschlagen. Ihre Differentialdiagnose gegenüber den echten Abszessen wird besprochen und ein charakteristischer, auf den Entstehungsmechanismus gegründeter röntgenologischer Symptomenkomplex beschrieben.

SUMMARY

Recently the common occurrence of emphysema has been indicated as having originated from stenosis of the vents during the course of pulmonary diseases in children and the name »pseudo abscess» of the lung has been suggested for this. Its differential diagnosis in view of the genuine abscesses is discussed and a characteristic roentgenological symptom complex, based on the mechanism of origin, is described.

RÉSUMÉ

Ces derniers temps on a attiré l'attention sur les cas fréquents de bulles d'emphysème se produisant à la faveur d'un rétrécissement à soupape au cours d'affections pulmonaires chez les enfants, et l'on a proposé pour elles la dénomination de »Pseudoabcès» du poumon. L'auteur traite de leur diagnostic différentiel d'avec les abcès véritables, et décrit un ensemble caractéristique de symptômes radiologiques, basé sur le mécanisme de leur production.

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